ADI Limited
Engineers, Architects, Planners,
Management Consultants, Surveyors
© 1988 ADI Limited

Open File Report 89-37

INDUSTRIAL MINERAL PRODUCTION AND CONSUMPTION IN NEW BRUNSWICK

VOLUME 2

INDUSTRIAL MINERALS USED PRIMARILY IN THE CONSTRUCTION INDUSTRY

by

ADI Limited
Fredericton, New Brunswick

Canada-New Brunswick Mineral Development Agreement
Entente Canada-Nouveau-Brunswick L'Exploitation Minérale

Natural Resources and Energy New Brunswick
Ressources Naturelles et Énergie Nouveau-Brunswick
Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

Price $11.30

This report has been prepared for:

Minerals and Energy Division
Department of Natural Resources and Energy
New Brunswick

Hon. Morris Green, Minister

1989

INDUSTRIAL MINERAL PRODUCTION AND CONSUMPTION

IN NEW BRUNSWICK

VOLUME 2

INDUSTRIAL MINERALS USED PRIMARILY

IN THE CONSTRUCTION INDUSTRY

This project was funded under the Canada-New Brunswick Mineral Development Agreement, a subsidiary agreement under the Economic and Regional Development Agreement.

Copies available by contacting:

Minerals and Energy Division
Department of Natural Resources
and Energy
P. O. Box 6000, Fredericton
New Brunswick E3B 5H1

1989

Report No.: Open File Report 89-37

Author: ADI Limited

Catalogue No.: ISSN 0712-4562

90-00791/

This report should be referenced in the following manner:

ADI LIMITED. 1989. Industrial mineral production and consumption in New Brunswick, Volume 2 - Industrial minerals used primarily in the construction industry. New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, Open File Report 89-37, 220 p.

PREFACE

From 1985-1989, the Province of New Brunswick, in conjunction with the Government of Canada, has initiated a number of mineral commodity studies through the Economic Development Program established under a Federal-Provincial Mineral Development Agreement. An important part of this agreement has involved studies designed in part to provide important marketing information on selected industrial minerals. These market-related projects have tended to concentrate on potential market growth areas primarily in North America, and particularly in areas where a New Brunswick producer could be competitive.

Whether it be building stone from Shediac, gypsum from Hillsborough or limestone from Saint John, industrial minerals have historically been important contributors to the economic growth and prosperity of New Brunswick. Today, industrial minerals are still important. Potash mining generates millions of dollars of salaries and business in the Sussex area, while the processing of phosphate rock with by-product sulphuric acid from a nearby lead smelter is a major industry in the Belledune-Bathurst region.

Preliminary figures for the value of industrial mineral production in New Brunswick was about $251 000 000 (Cdn) in 1988 compared to $197 000 000 in 1987. This represents an increase of twenty-two (22) percent. In 1988, industrial mineral production accounted for 31 percent of the total value of Provincial mineral production.

The manufacturing sector of the Province and surrounding areas consume substantial quantities of industrial minerals and their derived chemicals. Changing technology is making new demands on both the quality and quantities of industrial minerals consumed in the region. The requirement to document industrial mineral production in the Province as well as the consumption of these mineral commodities both, in the Province and adjacent areas, is becoming an increasingly important facet of responsible resource management.

Keenly aware of the importance of industrial minerals, the New Brunswick Department of Natural Resources and Energy has sponsored a review of industrial mineral supply and demand for New Brunswick (exclusive of granular and bedrock aggregate). The review was conducted under contract by ADI Limited and Three-D Geoconsultants Limited.

The purpose of the study is to provide as comprehensive and contemporary information as possible concerning the state of the industrial minerals industry in New Brunswick from both a producer's and consumer's point of view. Towards the achievement

of this goal, an assessment of the current supply/demand situation in the Province and adjacent reasonably accessible market areas was undertaken in an attempt to identify potential opportunities for market expansion and future development of indigenous industrial mineral resources. Another study objective is to indicate to various manufacturing industries where sources of various industrial mineral products are located in New Brunswick. Such an approach may be of some value in attracting new manufacturing industries to the Province. In addition, an attempt has been made to identify and document local market opportunties by showing producers where, in what quantities and under what circumstances industrial minerals and industrial mineral-based chemicals are being utilized within the Province and immediate surrounding areas.

Although this study focused primarily on the supply and demand of industrial minerals and industrial mineral-based chemicals produced and consumed in New Brunswick, the demand for similar products in market areas considered reasonably accessible to a local producer were also evaluated to some extent.

The results of the review were issued in the spring of 1989 and consist of a six volume report. Volume 1, 2 and 3 detail the history of specific industrial mineral production and consumption in New Brunswick and current demand within a market place easily accessible from the Province. Volume 4 provides demand projections for key industrial minerals, and describes the possible effects on future demand from environmental, technical, and other developments. Finally, Volumes 5 and 6 include a directory of New Brunswick's industrial mineral producers and consumers of industrial minerals within economic shipping distance of New Brunswick.

Component volumes of this extensive study are listed below:

Volume	Title	Open File Report
1.	Industrial Minerals Used Primarily in the Fertilizer Industry	89-36
2.	Industrial Minerals Used Primarily in the Construction Industry	89-37
3.	Industrial Minerals Used Primarily in the Chemical and Pulp and Paper Industries	89-38
4.	The Future of Industrial Minerals: General Trends in Consumption and Transportation	89-39
5.	Directory of New Brunswick Industrial Mineral Producers	89-40

Volume	Title	Open File Report
6.	Directory of Consumers of Industrial Minerals in Eastern Canada and the Northeastern United States	89-41

This volume addresses those selected industrial minerals consumed primarily in the construction industry - common clay/brick shale/expanded shale, gypsum, silica, dimension stone, cement and cement products, bentonite, pryophyllite and talc.

VOLUME 2

TABLE OF CONTENTS

BENTONITE	1
CEMENT AND CEMENT PRODUCTS	11
COMMON CLAY/BRICK SHALE/EXPANDED SHALE	49
DIMENSION STONE	75
GYPSUM	111
PYROPHYLLITE	147
SILICA	155
TALC	209

BENTONITE

BENTONITE

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	3
2.0	PRODUCTION STATUS IN NEW BRUNSWICK	4
3.0	CONSUMPTION	5
3.1	Drilling Mud	5
3.2	Foundry Sand	8
4.0	BIBLIOGRAPHY	10

LIST OF TABLES

		Page
TABLE 1	BENTONITE CONSUMPTION IN THE UNITED STATES, 1986	6

BENTONITE

1.0 INTRODUCTION

Definition. Bentonite is a clay comprised of montmorillonite minerals and formed by the weathering of volcanic or sedimentary rocks. There are two distinct types of bentonite: swelling, which has a high concentration of sodium and nonswelling, which has a high concentration of calcium. (B1)

Special properties. Swelling bentonite can swell by 15-20 times its dry volume when wet. Nonswelling bentonite has good adsorptive properties. (B1)

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

Bentonite production has not been undertaken in New Brunswick. Occurrences have been reported in the Minto-Chipman area in association with other clays and shales (B6). Commercial production has a low potential.

3.0 CONSUMPTION

Uses and quantities. Table 1 presents 1986 bentonite consumption information for the United States. Major uses (B2) include:

drilling muds (swelling)	36.5%
foundry sand (swelling and nonswelling)	21.9%
pelletizing iron ore (swelling)	9.3%
filtering, clarifying, decolorizing: animal oils, mineral oils and greases, vegetable oils (non-swelling)	5.5%

Figures for Canada are not available. However, the main uses are drilling mud, decolorizing mineral oils and catalysts.

3.1 Drilling Mud

Description. Drilling muds are used to:

a) replace well casings;

b) support the walls of the drill hole through the high specific gravity of the mud and the formation of an impervious mud cake along the hole walls; and

c) transport the drill cuttings out of the hole.

Research by the United States Corps of Engineers found a mixture of 6 percent bentonite in water is one of the best mud mixtures. However, heavier suspensions are used in highly pervious soils, loose sand and soft clays. Most drilling muds contain a number of industrial minerals including barite, swelling bentonite, and silica, depending upon the drilling requirements. (B4)

TABLE 1

BENTONITE CONSUMPTION IN THE UNITED STATES, 1986 (B2)

Use	Consumption			
	Non-swelling	Swelling	Total	
	Tonnes (M)	Tonnes (M)	Tonnes (M)	%
Domestic:				
Adhesives	--	0.010	0.010	0.4
Animal feed	0.039	0.063	0.102	4.0
Catalysts (oil refining)	0.005	*	0.005	0.2
Cement, portland	--	W	W	
Drilling mud	0.005	0.938	0.943	36.5
Filtering, clarifying decolorizing:				
Animal oils, mineral oils and greases, vegetable oils	0.139	0.002	0.141	5.5
Dissecant	0.012	--	0.012	0.5
Foundry sand	0.196	0.365	0.561	21.9
Glazes, glass, enamels	--	--	--	
Medical, pharmaceutical, cosmetics	--	0.006	0.006	0.2
Oils and grease absorbents	0.007	--	0.007	0.3
Paint	--	0.007	0.007	0.3
Pelletizing (iron ore)	--	0.238	0.238	9.3
Pesticides and related products	0.001	0.004	0.005	0.2
Water treatment and filtering	0.004	0.001	0.005	0.2
Waterproofing and sealing	0.005	0.048	0.053	2.1
Miscellaneous	0.065	0.052	0.117	4.6
SUBTOTAL	0.478	1.734	2.212	82.8
Exports:				
Drilling mud	--	0.152	0.152	5.9
Foundry sand	0.048	0.095	0.143	5.6
Other	0.008	0.025	0.033	1.2
SUBTOTAL	0.056	0.272	0.328	12.8
TOTAL	0.534	2.026	2.560	100.0

* - less than 0.001 tonnes (M)
W - withheld

Companies and locations. Drilling muds are used by a wide range of drilling companies from the large oil companies to local well and boring firms. The muds are supplied to the drillers by a few suppliers which mix and package the material. These firms include:

Canadian

Avonlea Mineral Industries Ltd., Regina, Saskatchewan
Dresser Minerals Division, Dresser Canada Inc., Calgary, Alberta
Wm. R. Barnes Company Western Ltd., Selkirk, Manitoba

American

Black Hills Bento-Nite, Mills, Natrona County, Wyoming
Dresser Industries Inc., Magcobar Minerals Div., Greybull, Big Horn County, Wyoming
Kaycee Bentonite Corp. Mills, Natrona County, Wyoming

Sources and suppliers. The bentonite industry appears to be vertically integrated. The largest suppliers are:

Dresser Co.
Halliburton Co. (through its subsidiary, Federal Bentonite, IMCO Services Div.)
Applied Industrial Materials Corp. (through its subsidiary International Minerals and Chemical Corp.)

All these firms mine, process, and market swelling and non-swelling bentonite. Most of the swelling bentonite for drilling mud comes from Wyoming and Montana. (B2)

Canada imports almost all of its drilling mud from the United States. (B3)

Specifications. Swelling bentonite is specified by physical and chemical parameters including particle size and swelling index. (B1)

Prices. In December 1986, swelling bentonite (200 mesh, bags, carload lots, f.o.b. mines) was quoted at $63.80 per tonne in the United States. The production value of swelling bentonite in the United States was $44.60 per tonne and of non-swelling bentonite, $58.90 per tonne in 1986. (B2)

In 1985, Canada imported 0.346 tonnes (M) of bentonite valued at $18.1 M and 0.007 tonnes (M) of drilling mud valued at $5.1 M. The unit values were $52.30 per tonne for bentonite and $729.00 per tonne for drilling mud. (B3)

Substitutes. While there are several industrial minerals and other additives which are used in drilling mud, none displaces swelling bentonite.

3.2 Foundry Sand

Description. Both swelling and non-swelling bentonite are used as a binder in foundry sand mixes. The non-swelling bentonite provides high green strength to the mold, the swelling bentonite provides dry strength*. (B1, B5)

Companies and location. See Drilling Mud.
Sources and supplies. See Drilling Mud.
Substitutes. See Drilling Mud.
Prices. See Drilling Mud.

---

* Most molds are formed using damp sand mixtures. A green sand mold is used while still damp; a dry sand mold is baked until it has the properties of soft brick and then is used.

Substitutes. Bentonite's low price, low reactivity and good binding strength make it difficult to displace for foundry molds.

4.0 BIBLIOGRAPHY (BENTONITE)

B 1 Ampian, Sarkis G. "Clays." Preprint, from Bulletin 675, Mineral Facts and Problems, 1985 Edition.

B 2 Ampian, Sarkis G. "Clays." Preprint, from the 1986 Bureau of Mines Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1987.

B 3 Vagt, G.O. "Bentonite." Publication, from Canadian Minerals Yearbook, 1986, Review and Outlook, Ottawa, Ont.: Canadian Government Publishing Centre, 1987.

B 4 Fang, Hsai-Yang and Winterkorn, Hans F. Foundation Engineering Handbook. New York: Vannostrand Reinhold, 1975.

B 5 Burton, Malcolm, S. Applied Metallurgy for Engineers. New York: McGraw-Hill Book Company, Inc., 1956.

B 6 Leveille, Johanne. "Inventory of Slate, Tuff, and Bentonite Deposits of New Brunswick." Department of Natural Resources and Energy, Minerals and Energy Division, Open File Report 77-13, 1977.

CEMENT

AND

CEMENT PRODUCTS

C E M E N T A N D C E M E N T P R O D U C T S

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	14
2.0	PRODUCTION STATUS IN NEW BRUNSWICK	19
3.0	CONSUMPTION	22
3.1	Ready-Mixed Concrete	22
3.2	Concrete Products	28
3.3	Building Materials Dealers	43
3.4	Contractors	44
3.5	Consumption Estimates	44
4.0	BIBLIOGRAPHY	46

C E M E N T A N D C E M E N T P R O D U C T S

LIST OF TABLES

		Page
TABLE 1	TYPES AND QUANTITIES OF MINERALS USED IN THE PRODUCTION OF PORTLAND CEMENT IN THE UNITED STATES, 1986	15
TABLE 2	PREDOMINANT COMPOUNDS IN PORTLAND CEMENT CLINKER	16
TABLE 3	NEW BRUNSWICK CEMENT PRODUCTION, 1956-1987	21
TABLE 4	SHIPMENTS OF PORTLAND CEMENT IN THE UNITED STATES (PRODUCED AND IMPORTED BY DOMESTIC PRODUCERS) BY CONSUMER, 1986	24
TABLE 5	SHIPMENTS OF PORTLAND CEMENT IN THE UNITED STATES (PRODUCED AND IMPORTED BY DOMESTIC PRODUCERS) BY TYPE, 1986	25
TABLE 6	CEMENT PLANTS WITHIN 400 KILOMETRES OF NEW BRUNSWICK	27
TABLE 7	CEMENT MORTAR AND CEMENT PRICES FOR SIX CITIES IN NORTHEASTERN NORTH AMERICA 1986-1988	29
TABLE 8	MAJOR MANUFACTURERS OF CONCRETE PRODUCTS WITHIN 800 KILOMETRES OF NEW BRUNSWICK	32

LIST OF FIGURES

		Page
FIGURE 1	CONSUMPTION OF PORTLAND CEMENT IN THE UNITED STATES, IN 1986	23

CEMENT AND CEMENT PRODUCTS

1.0 INTRODUCTION

Definition. **Portland cement** is a manufactured product made by first calcining a mixture of calcareous (see Table 1) and argillaceous (see Table 1) minerals (CM L) to form **clinker** and then pulverizing the clinker to a fine powder. It is a complex mixture of compounds (see Table 2).

There are five recognized types of portland cement:

- **Type I** or **regular** portland cement is used for general construction. Variations include **white** (which has a low concentration of ferric oxide), oil-well cement and quick-setting cement.

- **Type II** or **moderate-heat-hardening** or **sulfate-resisting** portland cement is used for applications requiring low heat production during setting* or for applications where the cement will be exposed to moderate levels of sulphate.

- **Type III** or **high-early-strength** (HES) portland cement has a higher rate of calcareous to argillaceous mineral (yielding more C_3S) and is ground finer than regular cement. It hardens and yields heat more quickly.

---

*Regular cement yields about 70-80 calories per gram (cal/g) after 7 days of setting and 80-95 cal/g after 28 days of setting. By definition Type II cement should not exceed 70 cal/g after 7 days or 80 cal/g after 28 days. Low heat production is useful for reducing concrete expansion in very large pours such as in dams and bridges.

TABLE 1

TYPES AND QUANTITIES OF MINERALS
USED IN THE PRODUCTION OF PORTLAND CEMENT
IN THE UNITED STATES, 1986 (CM 2)

Mineral Type		Quantity Tonnes (M)	%
Calcereous:	limestone (including aragonite, marble, chalk)	71.8	64.6
	cement rock (including marl)	21.4	19.3
	coral	0.9	0.8
	other	0.4	0.4
Argillaceous:			
	clay	5.2	4.7
	shale	3.0	2.7
	other (including bauxite aluminum dross, alumina, volcanic material, other)	0.2	0.2
Siliceous:	sand and calcium silicate	1.7	1.6
	sandstone quartzite, other	0.6	0.5
Ferrous:	iron ore, pyrites, millscale, other iron-bearing material	1.0	0.9
Other:	gypsum and anydrite	3.7	3.3
	blast furnace slag	0.1	0.1
	fly ash	0.6	0.5
	other	0.3	0.8
TOTAL		111.1	100.0

TABLE 2

PREDOMINENT COMPOUNDS IN PORTLAND CEMENT CLINKER (CM 1)

Formula	Name	Abbreviation
$2\ CaO.SiO_2$	Dicalcium silicate	C_2S
$3\ CaO.SiO_2$	Tricalcium silicate	C_3S
$3\ CaO.Al_2O_3$	Tricalcium aluminate	C_3A
$4\ CaO.Al_2O_3.Fe_2O_3$	Tetracalcium aluminoferrite	C_4AF
MgO	Magnesium oxide (in free state)	MgO

- **Type IV** or **low-heat** portland cement is used in applications requiring low heat generation. Examples include massive concrete pours such as dams where excessive heat can cause cracking and reduced strength. Low-heat cement has lower concentrations of C_3S and C_3A and higher concentrations of C_4AF. Heat evolution cannot exceed 60 cal/g after 7 days or 70 cal/g after 28 days.

- **Type V** or **sulfate-resisting** portland cement has a lower concentration of C_3A and a higher concentration of C_4AF. (CM 1)

Several additives are used in portland cement. Gypsum (4-5 percent) helps retard setting. Air entraining agents (small concentrations of tallow resin, or grease) increase the void ratio of concrete and improve resistance to freezing and thawing and to de-icing chemicals. (CM 1)

Other cements include pozzolan cement, high-alumina cement, special or corrosion-resisting cements and controlled cement. Pozzolans are materials such as fly ash or volcanic tuffs which become cementitious when mixed with lime. High-alumina cement is a fused mixture of limestone and bauxite which has a rapid setting rate, high early strength and superior resistance to sea and sulphate bearing waters.

Special cements are used in corrosive environments. Controlled cements use calcium sulfoaluminate (10-20 percent) to eliminate cracking. (CM 1)

Special properties. Cement and cement products are widely used for construction, building, and civil engineering applications because of the following properties:

a) adhesion - for mortar;

b) hardness;

c) compressive strength - but not tensile strength;

d) durability - concrete structures have withstood traffic and loading for hundreds of years;

e) workability - cements and concretes can be shaped, molded, and smoothed at normal temperatures and under normal conditions of humidity;

f) weight; and

g) relative low cost.

As cement and concrete technology have improved during the 1900s the applicability and consumption of these materials have grown steadily.

2.0 PRODUCTION STATUS IN NEW BRUNSWICK (CM 4, CM 9, CM 10, CM 11, CM 12)

In 1952, the Canada Cement Company (later Canada Cement Lafarge Ltd., and now Lafarge Canada Inc.) opened a cement plant at Havelock, N.B. At that time, the operation was the only producer in Atlantic Canada. The operation extracts a good quality limestone from a quarry near the plant. The quarried stone is crushed and ground. Silica, alumina, and iron oxide are added as required depending on the product requirements. The mixture is then burned in one of the two rotary kilns at the plant (the second kiln was added in 1966). The kiln discharge, roughly spherical in shape, is a fused, chemically complex mixture of calcium silicates and aluminates known as clinker. Clinker is mixed with gypsum (4 to 5 percent by weight) obtained from a nearby quarry at Intervale and ground to a fine powder to form Portland cement. (Portland cement was patented in 1824 in England and is the most common type of cement now produced. The term "Portland" was selected because the set cement resembled a building stone quarried on the Isle of Portland off the southern coast of England.) About 1.8 tonnes of raw material is required to manufacture 1.0 tonne of finished cement. About 1.7 tonnes are used to make clinker and the additional 0.1 tonne is added during the clinker grinding process.

The Lafarge operation at Havelock is termed a dry process plant with a crushing capacity of 450 tonnes per hour, a clinker capacity of 274 000 tones per year, and a grinding capacity of 330 000 tonnes per year. The kilns are oil-fired and are equipped with electrostatic precipitators to minimize emissions.

Production levels reached a peak during the 1978-79 period but declined in the early eighties in response to a downturn in construction, high energy costs, declining markets in the

Maritimes, limited export opportunities and related factors. Production of specialty products such as cement for offshore oil exploration programs were undertaken but this market also declined.

In 1983, the cement kilns were closed but the grinding operation was continued using clinker from another company operation in Brookfield, Nova Scotia. In 1987 the operation was discontinued for an indefinite period. The quarry continues to operate supplying raw stone to a nearby lime operation and aggregate to a subsidiary, Permanent Concrete Ltd. The site also serves as a distribution point for products from other company operations.

Table 3 illustrates the value of cement production in the Province.

TABLE 3

NEW BRUNSWICK CEMENT PRODUCTION (CM 13, CM 14)
1956-1987

Year	Tonnes	Current Dollars (Thousands)	Constant 1987 Dollars (Thousands)
1956	150165	$ 2 439	$11 704
1957	0	0	0
1958	163339	2 934	13 292
1959	155172	2 606	11 546
1960	147912	2 544	11 233
1961	155172	2 754	12 083
1962	154265	2 775	12 023
1963	147005	2 659	11 310
1964	157895	2 908	12 144
1965	160617	2 940	11 989
1966	221416	4 141	16 300
1967	208711	3 904	14 830
1968	E	2 696	9 837
1969	E	3 539	12 357
1970	E	3 297	11 147
1971	E	2 829	9 295
1972	E	4 564	14 317
1973	E	5 203	15 155
1974	E	5 672	14 774
1975	E	5 839	13 730
1976	E	8 967	19 766
1977	E	10 367	21 169
1978	E	15 794	29 633
1979	E	15 794	27 135
1980	E	14 002	21 837
1981	E	15 304	21 208
1982	E	17 165	21 479
1983	E	8 965	10 605
1984	E	14 567	16 515
1985	E	12 366	16 496
1986	E	9 526	10 002
1987	E	3 451	3 451

3.0 CONSUMPTION

Use and quantities. Table 4 presents the consumption of portland cement in the United States by consumer type in 1986. Ready-mixed concrete accounted for 71.9 percent of consumption; concrete products, 11.8 percent, building materials dealers, 5.0 percent and highway and other contractors, 4.5 percent and 4.9 percent, respectively (see Figure 1).

In terms of cement type, Types I and II (general use and moderate heat) accounted for 92.1 percent of consumption and Type III (high-early-strength), 3.6 percent in the United States in 1986 (see Table 5).

Canadian consumption is not tracked by consumer or cement type.

3.1 Ready-Mixed Concrete

Description. Cement alone has limited use but mixed in the form of concrete, it becomes a material of great versatility, strength, and value.

Ready-mix concrete is prepared using measured ingredients (cement, aggregate, water, additives) mixed under controlled conditions. It is then delivered to the construction site using special trucks.

Companies and locations. Most ready-mix firms supply material to a market area of only a few kilometres in radius. This is because concrete is heavy and therefore expensive to transport and must be placed relatively quickly after mixing. Thus, there were thirty ready-mix firms listed in New Brunswick in 1983. (CM 3) There are likely well over one hundred plants within 400 kilometres of the Province.

FIGURE 1

CONSUMPTION OF PORTLAND CEMENT IN THE UNITED STATES, IN 1986 (CM2)

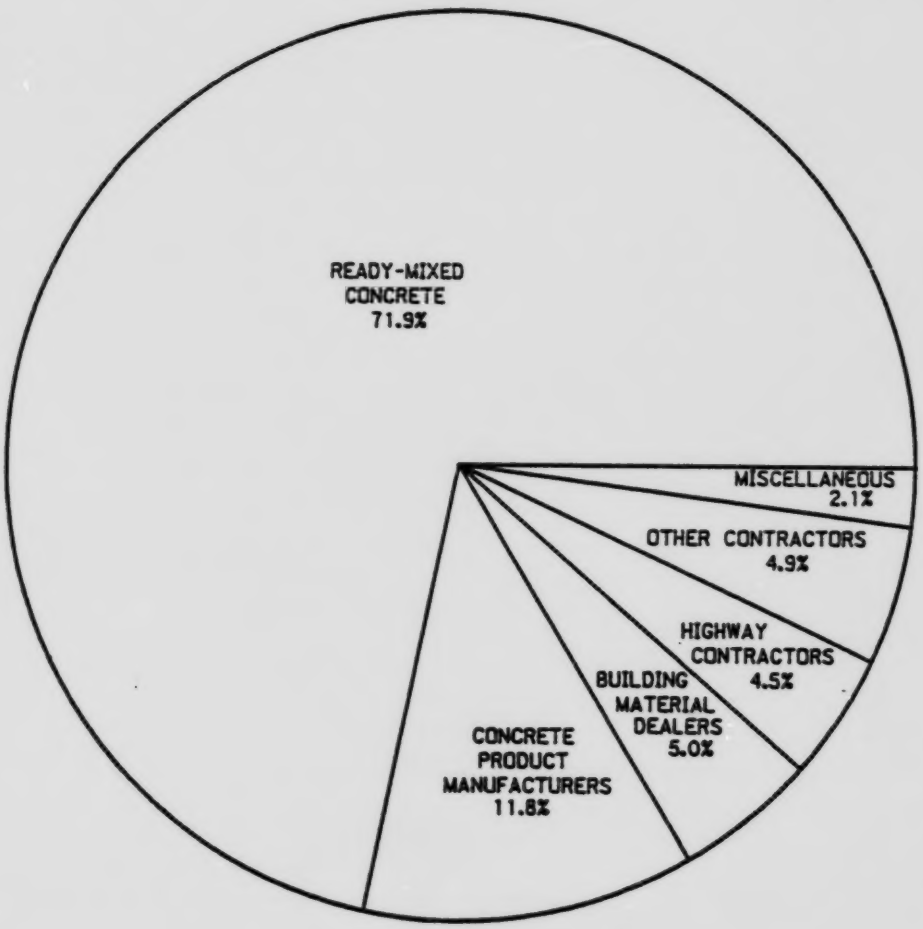


TABLE 4

SHIPMENTS OF PORTLAND CEMENT IN THE UNITED STATES*
(PRODUCED AND IMPORTED BY DOMESTIC PRODUCERS) BY CONSUMER, 1986
(CM 2)

Consumer	Quantity tonnes, M	%
Building material dealers	3.78	5.0
Concrete product manufacturers	9.01	11.8
Ready-mixed concrete	54.90	71.9
Highway contractors	3.41	4.5
Other contractors	3.73	4.9
Government agencies	0.20	0.3
Miscellaneous	1.34	1.8
TOTAL	76.36	100.0

*does not include Puerto Rico

TABLE 5

SHIPMENTS OF PORTLAND CEMENT IN THE UNITED STATES*
(PRODUCED AND IMPORTED BY DOMESTIC PRODUCERS)
BY TYPE, 1986 (CM 2)

Type	Quantity tonnes, M	%
General use and moderate heat (Types I and II)	78.44	92.1
High-early-strength (Type III)	3.03	3.6
Sulfate-resisting (Type V)	0.43	0.5
Oil well	1.02	1.2
White	0.32	0.4
Portland slag and portland pozzolan	0.76	0.9
Expansive	0.04	**
Miscellaneous	1.09	1.3
TOTAL	85.13	100.0

*does not include Puerto Rico

Sources and suppliers. According to the United States Bureau of Mines, cement plants "are usually located near a source of raw materials and within a 200 mile (320 kilometre) radius of a market area. Transportation costs restrict most cement production to a regional industry, with the exception of those plants located where the product can be shipped by relatively low-cost water transportation." (CM 4) The lists of cement plants and locations provided in Table 6 tend to confirm this assessment, with most plants having well-defined market areas and only one competitor, if any. These cement plants supply most ready-mix operations except if the operations use imported cement. The material is delivered in bulk with special trucks.

Specifications. The following CSA (Canadian Standards Association) specifications apply to cement used in Canada:

portland cement	CAN 3-A5-M83 (CSA)
masonry cement	CAN 3-A8-M83 (CSA)
hydraulic cement	CAN 3-A362-M83 (CSA)

Other, specialty cements are covered by specifications issued by ASTM (American Society for Testing and Materials). (CM 5)

In the United States, ASTM Standards (Section 4 of the Annual Book) and National Bureau of Standards specifications (for United States federal projects) are used for cement. The two standards differ slightly.

Frequently-used specifications.

portland cement	C150 (ASTM)
masonry cement	C-91-83a (ASTM)
expansive cement	C-845-80 (ASTM)

TABLE 6

CEMENT PLANTS WITHIN 400 KILOMETRES OF NEW BRUNSWICK (CM 5, CM 6)

Province/State	Company	Location	Size	Capacity-Tonnes/Year Clinker (thousands)	Capacity-Tonnes/Year Grinding (thousands)	Notes
New Brunswick	Lafarge Canada Inc.	Havelock	01	300	315	(2) kilns, oil and coal-fired (plant closed and put on standby in 1987)
Newfoundland	North Star Cement Limited	Corner Brook	03	120	250	(1) kiln, oil-fired
Nova Scotia	Lafarge Canada Inc.	Brookfield	03	458	485	(2) kilns, oil and coal-fired
Quebec	Lafarge Canada Inc.	St. Constant	03	902	955	(2) kilns, oil and gas-fired
	Ciment Quebec Inc.	St. Basile	03	1 106	575	(3) kilns, oil-fired
	Miron Inc.	Montreal	04	840	1 000	(2) kilns, oil and gas-fired
	St. Lawrence Cement Inc.	Beauport	NA	598	550	(2) kilns, coal and oil-fired
	Independent Cement Inc.	Joliette	NA	976	1 000	(4) kilns, coal and oil-fired
Maine	Dragon Products Co., a sub. of Passamaquoddy Properties	Thomaston	NA	NA	NA	Gray Portland Masonry

NA - not available

Size Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

Prices. In 1986, Canadian cement production was valued at $78.60 per tonne; United States production was valued at $66.80 (Cdn) per tonne.

Prices for cement, mortar and concrete for six northeastern North American cities are presented in Table 7.

Substitutes. Cement is by far the most common binder for ready-mix concrete and concrete products. The only substitute of note is fly ash which has pozzolonic properties and is available in large quantities as a waste product of coal-fired energy.

There are several materials which compete with ready-mix concrete and concrete shapes, including: structural steel, stone, bricks, lumber, asphalt, glass, and aluminum. However, none of these materials are displacing concrete.

3.2 Concrete Products

Description. There is a large market for precast concrete products either as structural elements (beams, wall panels, floor elements, columns) or decorative products (fountains, ornaments, steps, curbs). Better concrete improved moulds and technical advances (lightweight concrete, coloured concrete) have increased the range and popularity of precast products.

Companies and locations. With the proper protection concrete products manufacturers can ship their products anywhere. However, the high weight and relatively low value of most precast products limit market areas to a radius of 400 kilometres at most and usually to areas within 200 kilometres of the plant.

Table 8 lists major concrete products manufacturers within 400 kilometres of New Brunswick.

TABLE 7

CEMENT MORTAR AND CEMENT PRICES FOR
SIX CITIES IN NORTHEASTERN NORTH AMERICA
1986-1988 (CM 7)

City	Product	Price									
		1986				1987				1988	
		Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr
Boston	Bulk cement (tonne)	95.50	100.30	100.30	90.90	90.90	90.90	90.90	90.90	90.90	95.70
	Bags (43 kg)	6.60	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.55
	Mortar (32 kg)	4.90	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.50
	Concrete block, sand (20 x 20 x 40 cm, per block)	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.30	1.30
	Concrete ready-mix, (tonne)										
	21 Mpa	70.30	74.50	71.50	71.50	74.50	74.50	71.50	71.50	71.50	71.50
	34 Mpa	77.60	74.50	78.80	78.80	81.80	81.80	78.80	78.80	71.50	71.50
New York	Bulk cement (tonne)	81.20	--	90.90	75.15	75.15	75.15	95.75	95.75	95.75	95.75
	Bags (43 kg)	7.95	7.95	7.95	7.95	7.95	7.95	8.35	8.35	7.95	7.95
	Mortar (32 kg)	7.45	7.45	7.45	7.45	7.45	7.45	7.80	7.80	7.45	7.45
	Concrete block, sand (20 x 20 x 40 cm, per block)	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
	Concrete ready-mix, (tonne)										
	21 Mpa	86.40	76.35	81.70	84.85	84.85	76.35	90.90	90.90	84.85	84.85
	34 Mpa	--	88.50	94.65	96.95	96.95	96.95	109.10	109.10	103.00	103.00

TABLE 7 (continued)

City	Product	Price									
		1986				1987				1988	
		Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr
Philadelphia	Bulk cement (tonne)	85.80	85.80	72.70	72.70	72.70	81.20	81.20	80.00	80.00	81.20
	Bags (43 kg)	5.25	5.25	5.25	5.25	5.25	5.25	5.25	5.50	5.50	4.80
	Mortar (32 kg)	4.10	4.10	4.10	4.10	4.10	4.10	4.10	4.30	4.30	3.75
	Concrete block, sand (20 x 20 x 40 cm, per block)	--	--	--	--	--	--	--	--	--	--
	Concrete ready-mix, (tonne)										
	21 Mpa	55.75	55.75	55.75	55.75	55.75	55.75	55.75	55.75	55.75	55.75
	34 Mpa	64.25	64.25	64.25	64.25	64.25	64.25	64.25	64.25	64.25	64.25
Pittsburgh	Bulk cement (tonne)	80.40	80.40	80.40	80.40	80.40	84.00	84.00	72.70	72.70	72.70
	Bags (43 kg)	5.20	5.20	5.20	5.20	5.20	5.40	5.40	6.05	6.05	6.05
	Mortar (32 kg)	3.90	3.90	3.90	3.90	3.90	4.00	4.00	4.70	4.70	4.70
	Concrete block, sand (20 x 20 x 40 cm, per block)	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90
	Concrete ready-mix, (tonne)										
	21 Mpa	58.80	57.00	57.00	57.00	57.00	60.60	60.60	60.60	60.60	60.60
	34 Mpa	64.85	61.80	61.80	61.80	61.80	65.45	65.45	65.45	65.45	65.45

TABLE 7 (continued)

City	Product	Price									
		1986				1987				1988	
		Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr
Montreal	Bulk cement (tonne)	84.10	84.10	85.60	85.60	85.60	85.60	85.60	85.60	91.85	91.85
	Bags (43 kg)	4.70	4.70	4.80	4.80	4.80	4.80	4.80	4.80	5.10	5.10
	Mortar (32 kg)	3.35	3.35	3.40	3.40	3.40	3.40	3.40	3.45	3.75	3.75
	Concrete block, sand (20 x 20 x 40 cm, per block)	.85	.95	.95	.95	.95	.95	1.05	1.05	1.05	1.05
	Concrete ready-mix, (tonne)										
	21 Mpa	43.25	54.40	56.45	56.45	56.45	56.45	59.85	59.85	59.85	59.85
	34 Mpa	51.90	64.45	64.80	64.80	64.80	64.80	77.45	77.45	77.45	77.45
Toronto	Bulk cement (tonne)	106.70	106.70	107.70	107.70	110.65	110.65	102.55	102.55	107.10	107.10
	Bags (43 kg)	6.55	6.55	6.30	6.30	6.65	6.80	6.80	6.80	6.90	6.90
	Mortar (32 kg)	5.15	5.15	3.65	3.65	5.70	5.70	5.70	5.70	5.45	5.45
	Concrete block, sand (20 x 20 x 40 cm, per block)	1.05	1.05	1.05	1.05	1.15	1.15	1.15	1.30	1.30	1.30
	Concrete ready-mix, (tonne)										
	21 Mpa	78.15	78.20	78.95	78.95	81.35	81.35	81.35	81.35	86.80	86.80
	34 Mpa	91.00	91.00	91.90	91.90	96.35	96.35	96.35	96.35	102.25	102.25

TABLE 8

MAJOR MANUFACTURERS OF CONCRETE PRODUCTS WITHIN 800 KILOMETRES OF NEW BRUNSWICK*
(CMB, TRADE DIRECTORIES)

Province/State	Company	Location	Size	Notes
New Brunswick	A&P Concrete Products Ltd.	Sainte-Marie-de-Kent	01	Concrete, septic tanks, concrete steps, and other concrete basic products
	A-1 Pumping Service Ltd.	St. Stephen	01	Concrete septic tanks, burial vaults and other concrete basic products
	Babineau Concrete Lawn Ornaments	Notre-Dame	01	Concrete ornaments
	C&U Belliveau Concrete Products Ltd.	Shediac	01	Concrete building blocks, concrete brick
	Gerard Benoit Monuments	Sheila	01	Concrete monuments, slabs
	Beton Gloucester Ltee.	Bertrand	01	Concrete building blocks
	Beton S.G.D. Concrete Enrg.	Bathurst	01	Concrete building blocks, concrete brick
	Cormier Ornement de Parterre Enrg.	Grande-Anse	01	Concrete ornaments
	Diamond Concrete Ltd.	Minto	01	Precast concrete, concrete septic tanks, concrete building blocks
	Dundee Cement Products Ltd.	Dundee	01	Concrete block, brick, patio slabs
	Gilbert Septic Tanks	Beresford	01	Concrete septic tanks
	Grand Falls Precast	Sainte-André	01	Concrete septic tanks
	Lameque Ready-Mix	Lameque	01	Patio slabs, concrete products

*Size Code at end of table

TABLE 8 (continued)

Province/State	Company	Location	Size	Notes
New Brunswick (continued)	LeBlanc Septic Tanks	Newcastle	01	Concrete septic tanks
	Leeuw Concrete	Fredericton	01	Precast concrete, concrete septic tanks, concrete steps
	McGuire Bros.	Renforth	01	Concrete septic tanks
	Newcastle Ready-Mix Ltd.	Newcastle	01	Concrete blocks, ready-mix concrete
	Permacon Madawaska	Saint-Jacques	01	Concrete blocks, concrete pipe and manholes
	Permaconc Precast Ltd.	Shediac	01	Concrete steps, concrete septic tanks, precast concrete
	Guy Richard Concrete Lawn Ornaments Ltd.	Haute-Aboujagane	01	Concrete lawn furniture, ornaments
	Scott Precast Products (1984) Ltd.	Fredericton	01	Precast concrete
	Gordon Shaw Concrete Products Ltd.	Saint John	01	Precast concrete
	L.E. Shaw Limited	Fredericton	01	Concrete building blocks
	L.E. Shaw Limited	Moncton	01	Concrete pipe and manholes
	Strescon Limited	Saint John	02	Concrete pipes and manholes, precast concrete, and other concrete products
	Walton's Concrete Lawn Ornaments	Rothesay	01	Concrete products, concrete blocks, tables, ornaments, furniture (lawn)
	White's Precast Concrete Ltd.	Centreville	01	Precast concrete, concrete septic tanks

TABLE 8 (continued)

Province/State	Company	Location	Size	Notes
New Brunswick (continued)	Wilson Concrete Pipe	Red Bank	01	Concrete pipe and manholes
Newfoundland	Burin Redymix Ltd.	St. John's	01	Concrete blocks, concrete ready-mixed
	Coastal Sand & Gravel Ltd.	Holyrood	02	Concrete products
	Concrete Products	St. John's	02	Concrete blocks, concrete products
	Dawe's Concrete Products Ltd.	Bay Roberts	01	Concrete blocks
	Island Precast Limited	Pasadena	01	Patio slabs, ornaments
	J.T.K. Precast Limited	Foxtrap	01	Precast concrete products, concrete pipe
	The Lundrigan Group Ltd.	Cornerbrook	01	Concrete blocks, precast concrete products, prestressed concrete
	The Lundrigan Group Ltd.	St. John's	02	Concrete products, concrete blocks, precast concrete products
	McCurdy Ready Mix Ltd.	Gander	01	Concrete blocks, concrete ready-mixed
	Ornamental Concrete Ltd.	St. John's	01	Patio slabs, garden accessories, precast concrete products
	Pinsents' Concrete Limited	Stephenville	01	Patio slabs, precast concrete products
Nova Scotia	Barrios Concrete Ornaments Ltd.	Bedford	01	Park benches, concrete products
	Borcherdt Concrete Products	Yarmouth	01	Concrete septic tanks, manholes, concrete products, furniture (commercial), panels (structural wall)

TABLE 8 (continued)

Province/State	Company	Location	Size	Notes
Nova Scotia (continued)	Brookfield Concrete Products Ltd.	Brookfield	01	Precast concrete products, septic tanks, concrete tile, stairs
	E.L. Casey Construction Ltd.	Amherst	01	Concrete blocks, septic tanks, ready-mix concrete
	E.L. Casey Construction Ltd.	Truro	01	Concrete slabs, concrete blocks
	Chester Precast Ltd.	Chester	01	Concrete septic tanks, precast concrete products
	Cureggio General Construction Ltd.	Wallace	01	Precast concrete products, buildings (prefabricated)
	Dauphinee Memorial Art (1984) Ltd.	Shelburne	01	Monuments, fireplaces, natural stone
	Dowe Concrete Products Ltd.	Amherst	01	Concrete products, precast concrete
	C. Robert MacKenzie Enterprises	Westville	01	Concrete products, septic tanks
	Frank C. Nickerson	West Head	01	Weights (balancing)
	Pioneer Ready Mix Ltd.	Sydney	01	Precast concrete products, septic tanks, concrete blocks
	Ram Contracting Ltd.	New Minas	01	Precast concrete products, concrete ornaments
	Residential Concrete Products Ltd.	Lower Sackville	01	Concrete products, burial vaults, precast concrete products, ornamental, concrete steps and stairs

TABLE 8 (continued)

Province/State	Company	Location	Size	Notes
Nova Scotia (continued)	V.J. Rice Concrete Limited	Bridgetown	01	Precast concrete, ready-mixed concrete
	Gordon Shaw Concrete Products Ltd.	Windsor	01	Concrete products, precast concrete products, curbing, concrete steps and stairs, septic tanks
	L.E. Shaw Limited	Lantz	03	Concrete blocks, precast concrete products
	L.E. Shaw Limited	Sydney	01	Concrete products including brick and block
	Smith's Ready Mix	Sheet Harbour	01	Septic tanks, precast concrete, ready-mix concrete
	South Shore Ready Mix	Bridgewater	01	Concrete blocks, interlocking pavers, ready-mix concrete, split fire brick
	South Shore Ready Mix Ltd.	Chester	01	Concrete blocks, concrete bricks, ready-mix concrete
	SouthShore Ready-Mix Ltd.	Brooklyn	01	Concrete blocks, concrete bricks, ready-mix concrete
	Strescon Ltd.	Bedford	02	Precast and prefabricated concrete
	Sydney Residential Concrete Products Ltd.	Sydney	01	Concrete products, concrete septic tanks
	Tingley Monuments Ltd.	Amherst	01	Memorial monuments
	Lawrence S. Vienotte Enterprises Limited	Mahone Bay	01	Concrete products, concrete septic tanks, concrete ready-mix
	Whitford Concrete Products Ltd.	Malagash Point		Septic tanks, concrete blocks

TABLE 8 (continued)

Province/State	Company	Location	Size	Notes
Prince Edward Island	Cambell's Concrete Ltd.	Charlottetown	01	Concrete septic tanks, concrete products
	Concrete Tile Co. Ltd.	Charlottetown	01	Concrete products, concrete tile
	Gaudette's Transit Mix Ltd.	Tignish	01	Concrete septic tanks, concrete ready-mixed, asphalt paving materials
	Jackson's Concrete Products Ltd.	Murray Harbour	01	Concrete products
	MacLean's Ready Mix Concrete Ltd.	Souris	01	Concrete products including brick and block
	MacLean's Ready Mix Concrete Ltd.	Victoria Cross	01	Concrete block
	Peters Monuments Limited	Summerside	01	Monuments, fireplaces
	R&A Concrete Lawn Ornaments	Albany	01	Concrete products, concrete ornaments
	M.F. Schurman Co. Ltd.	Summerside	01	Concrete products, concrete ready-mix
Quebec	Aubert & Marios Ltee	St. Etienne-de-Lauzon	01	Concrete pipes, sidewalk and garden slabs, blocks
	Beton Bolduc	Sainte-Marie	01	Concrete blocks, septic tanks, floors for pigsties and cow barns, prefabricated porches
	Beton Laurier Inc.	Laurier Station	01	Precast concrete walls
	Beton Provincial Ltee	Matane	03	Concrete pipes, blocks, mixed concrete
	Beton Provincial Ltee	Hauterive	01	Concrete pipes and blocks

TABLE 8 (continued)

Province/State	Company	Location	Size	Notes
Quebec (continued)	Beton Provincial Ltee	Rimouski	01	Ready-mixed concrete, street curbs, sewer items, pipe
	Beton Tremblay Inc.	Normandin	01	Ready-mixed concrete, concrete blocks, crushed stone
	Beton's Marbo Enr.	Chicoutimi	01	Artificial stones
	Bloc De Ciment Audet Enr.	La Malbaie	01	Concrete blocks, pipes and squares
	Blocks De Ciment Montmagny Enr.	Montmagny	01	Concrete blocks
	Endore Boivin	Chicoutimi	01	Concrete products, tiles, steps and concrete borders for lawns
	L.A. Brouillette Ltee	St.-Narcisse	01	Concrete pipes and tiles for patios and swimming pools
	Ciment St.-Laurent	Quebec	03	Concrete - prefabricated
	Cimenterie Beaudoin Inc.	Pont Rouge	01	Concrete well curbing, pipes, septic tanks, blocks and tiles
	Cimentiers De St.-Flavien Ltee	St.-Flavien	01	Concrete pipes, septic tanks, surface wells, patio stones
	La Cimentrie Genest Inc.	St.-Basile	01	Concrete blocks, pipes and septic tanks
	Deco Beton Enr.	Sept Iles	01	Patio tiles, concrete bricks
	Dunbrick Limitee	Chicoutimi	01	Concrete blocks, septic tanks, manholes, precast items
	Entreprises R. Drouin Ltee	St.-Georges-Est	01	Concrete pipes and patio tiles

TABLE 8 (continued)

Province/State	Company	Location	Size	Notes
Quebec (continued)	Foyers Feu Ardent Inc.	Bernieres	01	Fireplaces
	Foyers Lanquette Ltee	Sainte Catherine	01	Concrete and stone fireplaces
	Gelinite Inc.	Sillery	01	Drain pipes and tiles, water intake pipes, septic tanks and wells
	Gosselin et Fils	Thetford Mines	03	Concrete blocks, pipes, bricks, sidewalk tiles, septic tanks, concrete pre-fabricated buildings, ready-mixed concrete
	Grenons Freres Limitee	La Baie	02	Concrete pipes and blocks, calcite bricks and blocks
	Industries Fortier Ltee	St.-Henri-De-Levis	02	Concrete pipe and blocks, catch basins, manholes
	Pavi-Bric Inc.	Beauport	01	Concrete products, interlocking bricks
	Pelletier & Fils Ltee	St.-Pacome	01	Rainforced concrete pipes
	Pepiniere Paysagiste Tecchio Enr.	Sainte-Foy	01	Concrete patio tiles
	Les Pierres Levisiennes Inc.	St.-David-De-L'Auberiviere	01	Concrete products, patio tiles and decorative items
	Produits Alba Inc.	Bagotville	02	Concrete pipes, cement blocks, calcite bricks
	Produits Alba Inc.	Dolbeau	01	Bricks, blocks
	Produits De Beton Rimouski Inc.	Sainte-Anne-De-La-Pointe-Au-Pere	01	Concrete blocks, chimney blocks, concrete pipe

TABLE 8 (continued)

Province/State	Company	Location	Size	Notes
Quebec (continued)	Produits De Beton St-Fabien Enr.	Saint-Fabien	01	Concrete pipes
	Produits De Ciment Le Clerc Ltee	Saint-Felicien	01	Concrete blocks, bricks, chimney blocks, patio tiles and steps, drain pipes, sewer pipes, culvert pipes and ornamental blocks, septic tanks, street gutters
	Ralston Purina Canada Inc.	Saint-Romuald-D'Etchemin	01	Concrete staves for silos
	Tuilco Ciment Inc.	Charlesbourg	01	Tiles, steps, sidewalks, edges and decorative articles
	Tuiles Laurentiennes	Bon Pasteur	01	Concrete tiles
	J.M. Turcotte Ltee	Trois-Pistoles	01	Concrete products
	Les Tuyaux De Ciment L'Islet Enr.	L'Islet	01	Concrete pipes
	Les Tuyaux Vibres Portneuf Enr.	Saint-Casimir	01	Reinforced concrete pipes for culvert and sewers
	Verreault Frontenac Inc.	Limoilou	01	Concrete pipes
Maine	American Concrete Industries Inc.	Auburn	02	Precast concrete steps
	American Concrete Industries Inc.	Bangor	02	Tiles, steps, vaults and septic tanks
	Aroostacast Inc.	Presque Isle	01	Concrete products

TABLE 8 (continued)

Province/State	Company	Location	Size	Notes
Maine (continued)	Ronald Atwood	Topsham	01	Precast cement products, batching cement, sewage treatment plants
	Joseph Baum	South Thomaston	01	Cement vaults, liners and septic tanks, well curbs
	Doran Inc.	Leeds	01	Reinforced concrete pipe, catch basins and manholes
	Elm Street Vault Inc.	Biddeford	01	Concrete burial vaults
	Gagne & Son	Belgrade	01	Concrete blocks
	Gagne & Son Concrete Blocks Inc.	Augusta	01	Concrete blocks, septic tanks and well tiles, building materials
	Geneat Brothers Inc.	Sanford	01	Concrete products, septic tanks, well tile, burial vaults
	Houlton Ready-Mix Inc.	Houlton	01	Ready-mix concrete sand
	Madawaska Brick and Block Corp.	Frenchville	01	Cement brick, concrete block and steps, septic tanks
	Madawaska Brick and Block Corp.	Madawaska	01	Concrete products, ready-mixed concrete and construction accessories
	Maine Shawnee Step Co. Inc.	Auburn	02	Precast concrete steps, patio stones
	Mecaw Industries	Portland	02	Cement products
	Mininni Vito Inc.	Biddeford	01	Concrete blocks
	Morin Brick Co.	Danville	02	Water struck and wire cut brick

TABLE 8 (continued)

Province/State	Company	Location	Size	Notes
Maine (continued)	Portland Wilbert Vault	Westbrook	01	Precast concrete products, burial vaults
	Pre-Case Concrete Products of Maine Inc.	Topsham	01	Concrete products
	Precast Erectors Inc.	Auburn	01	Concrete products
	Precast Inc.	Gray	01	Precast crib type retaining walls
	Prestressed Concrete Industries	Auburn	01	Structural prestressed concrete products for buildings, bridges, marine structures
	George R. Roberts Inc.	Biddeford	01	Concrete septic tanks, well tile, flow diffuser area components
	Saco Brick Co.	Saco	01	Cement products
	Superior Concrete Co. Inc.	Auburn	02	Concrete burial vaults, septic tanks, well tile, lift stations, curbing and agricultural precast, chlorinators, utility products
	Wilhelmsen Concrete Products Co.	Westbrook	01	Concrete building blocks

Size Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

Sources and suppliers. Most concrete products manufacturers would use cement from local cement plants. Some manufacturers would use imported cement. (See Table 6).

Specifications. See Ready-Mixed Concrete.

Prices. See Ready-Mixed Concrete.

Substitutes. See Ready-Mixed Concrete.

3.3 Building Materials Dealers

Description. Many small contractors and do-it-yourselfers mix their own concrete using cement purchased at building materials dealers.

Companies and locations. There are hundreds of building materials dealers within 400 kilometres of New Brunswick. Most dealers are part of buyer groups or chains (Home Hardware, Kent Building Supplies, Beaver Lumber). These groups buy material in large quantities at discounted prices and then distribute it to member outlets. Other groups and chains include Canadian Tire, Dominion Hardware, True Value, Woolco, Do-It-Centre, K-Mart, Lumberland, Monsieur Dismat, and Trust Worthy.

Sources and suppliers. The producers supply this market with bags of cement, usually in 43 kilogram size. Most of this material is supplied by local producers, some by importers.

Specifications. See Ready-mixed Concrete.

Prices. See Ready-mixed Concrete.

Substitutes. See Ready-mixed Concrete.

3.4 Contractors

Description. Medium- and large-sized contractors frequently mix concrete on-site using bagged or bulk cement.

Companies and locations. There are several dozen large and medium-sized contractors within 400 kilometres of New Brunswick. Most would order their cement from local producers but some would use cement imported from outside the region.

Sources and suppliers. Most of this material is supplied by local cement producers, some by imported material.

Specifications. See Ready-mixed Concrete.

Prices. See Ready-mixed Concrete.

Substitutes. See Ready-mixed Concrete.

3.5 Consumption Estimates

The consumption of cement within the extended market area of the Atlantic Provinces, the Gaspé, and Maine is likely equal to the production of cement within the Region - about 1 100 000 tonnes per year from three plants (Newfoundland, Nova Scotia, Maine). In turn, most of the Maritime demand is met by the Lafarge Canada plant in Brookfield, N.B. It has a clinker capacity of 458 000 tonnes per year and a grinding capacity of 485 000 tonnes per year. Cement is a relatively heavy and low-valued product and cannot be transported economically for long distances.

Ready-mix. Maritime firms produce about 600 000 - 700 000 cubic metres of ready-mix concrete each year, consuming 200 000 - 230 000 tonnes of portland cement*.

Concrete products. Maritime firms produce over $50M of concrete products annually. These products include concrete bricks, paving stones, pipe, steps, structural members (beams, columns) and septic tanks. Producing these products takes 60 000 - 70 000 tonnes of portland cement.

Building supply dealers. It is estimated that 5000 tonnes of cement is sold by dealers in the Maritimes each year to homeowners and small contractors.

Contractors. Large contractors in the Maritimes use an estimated 15 000 - 20 000 tonnes of portland cement each year.

Total. Total annual cement consumption in the Maritimes is estimated at:

Ready-mix	- 200 000 - 230 000	tonnes
Concrete products	- 60 000 - 70 000	
Building supply dealers	- 5 000	
Contractors	- 15 000 - 20 000	
TOTAL	280 000 - 325 000	tonnes

---

*about 330 kg of cement for each cubic metre of ready-mix concrete

4.0 BIBLIOGRAPHY (CEMENT AND CEMENT PRODUCTS)

CM 1 Austin, George T. and Shreve, Randolph N. Chemical Process Industries. 3rd ed. McGraw-Hill: Montreal, Que., 1977.

CM 2 Johnson, Wilton. "Cement." Preprint, from 1986 Bureau of Mines Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1987.

CM 3 Davis, Dallas W. Ready Mix Concrete Producers, Activity and Employment. Telephone Survey 16 June 1983.

CM 4 Johnson, Wilton, "Cement." Preprint, from Bulletin 675, Mineral Facts and Problems, 1985 Edition.

CM 5 Vagt, O. "Cement." Publication from Canadian Minerals Yearbook 1987, Ottawa, Ont.: Canadian Government Publishing Centre, 1988.

CM 6 U.S. Department of the Interior-Bureau of Mines. Directory of Cement Producers in 1985, Mineral Industry Surveys, 1985.

CM 7 "Market Prices." ENR, The McGraw-Hill Construction Weekly, January 1986-April 1988.

CM 8 ADI Limited. "Aggregate Market Study for New Brunswick and Nova Scotia." Supply and Services Canada, June 1988.

CM 9 O'Driscoll, M. "Cement Trade and Industry, Charting its Changing Course." Industrial Minerals, November 1987.

CM 10 Carroll, Barbara, M.W. "New Brunswick's Mineral Industry 1986." New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, Information Circular 87-1, 1987.

CM 11 Chandra, James J., Leger, J. Victor and Taggart, James L.C. "A Report on the New Brunswick Mining Industry Occupation and Economic Outlook to 1995." New Brunswick Department of Natural Resources and Energy, Mineral Resources Division, July 1986. Open File Report 86-13.

CM 12 Stonehouse, D.H. "Cement." Publication from Canadian Minerals Yearbook 1986, Review and Outlook, Ottawa, Ont.: Canadian Government Publishing Centre, 1987.

CM 13 Chandra, James J. "Mineral Production Statistics, 1899-1985 New Brunswick." New Brunswick Department of Forest, Mines and Energy, Mineral Resources Division, Open File Report 86-2, 1986.

CM 14 "Canada's Mineral Production, Preliminary Estimates 1987." Statistics Canada Catalogue 26-202, 1988.

COMMON CLAY

BRICK SHALE

EXPANDED SHALE

COMMON CLAY/BRICK SHALE/ EXPANDED SHALE

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	52
2.0	PRODUCTION STATUS IN NEW BRUNSWICK	54
3.0	CONSUMPTION	57
	3.1 Brick, Tiles and Other Construction Materials ..	57
	3.2 Lightweight Aggregate	69
	3.3 Cement	71
	3.4 Consumption Estimates	72
4.0	BIBLIOGRAPHY	73

COMMON CLAY/BRICK SHALE/ EXPANDED SHALE

LIST OF TABLES

		Page
TABLE 1	NEW BRUNSWICK CLAY PRODUCTS PRODUCTION, 1946-1987	56
TABLE 2	COMMON CLAY AND SHALE SOLD OR USED BY PRODUCERS IN THE UNITED STATES IN 1986	58
TABLE 3	CHARACTERISTICS OF CLAY PRODUCERS AND CONSUMERS WITHIN 800 KILOMETRES OF NEW BRUNSWICK	61
TABLE 4	SPECIFICATIONS RELATING TO BRICK AND TILE	66
TABLE 5	VALUE OF COMMON CLAY AND SHALE SOLD OR USED BY PRODUCERS IN THE NORTHEASTERN UNITED STATES (1983-1986)	67
TABLE 6	PRICES PAID FOR STRUCTURAL CLAY PRODUCTS IN CITIES WITHIN 800 KILOMETRES OF NEW BRUNSWICK .	68

LIST OF FIGURES

		Page
FIGURE 1	COMMON CLAY AND SHALE SOLD OR USED BY PRODUCERS IN THE UNITED STATES IN 1986	59

COMMON CLAY/BRICK SHALE/EXPANDED SHALE FOR LIGHTWEIGHT AGGREGATE

1.0 INTRODUCTION

Definition. "Common clay is a clay or clay-like material that is sufficiently plastic to permit ready molding and that vitrifies below 1100°C."(C4) Clay is composed of hydrous silicates--that is silica, alumina, and water--plus other minerals such as iron and alkalies. It is earthy and fine-grained in texture. Shale is a sedimentary rock originating from clay deposits which have been laminated under pressure.

Special properties. Common clay has been used for thousands of years in the production of a variety of structural products and is still among the commonly used industrial minerals. There are many reasons for the popularity of common clay and brick shale:

1. Abundance. Common clay reserves are virtually inexhaustable.

2. Low cost. It is easy to mine and usually requires little processing prior to use.

3. Malleability. Wet clay can easily be formed into many shapes: large or small, massive or intricate, rough or smooth.

4. Strength. Clay products when fired have good strength under compression (not under tension, however).

5. Weight. The weight of structural clay products improves overall strength of the structure, especially as most clay structures are compression structures.

6. Hardness. Fired clay products are hard and durable.

Clay and shale also have disadvantages:

1. Brittleness. Most clay products are quite brittle.

2. Weight. The high weight to volume ratio of clay products make them unsuitable for many applications. It makes them expensive to transport.

3. Low tensile strength. Clay products are weak in tension and cannot be stretched or bent.

2.0 PRODUCTION STATUS IN NEW BRUNSWICK (C10, C11, C12)

The production of "common" clay and brick shale has a long history in the Province. Brick kilns were common at many localities and the source of clay for these "manufacturers" was nearby. Data on the characteristics of some of these deposits is available (C11, C12). However, the quantities of raw material used has not been well documented. To some extent this may be a reflection of the inclusion of this commodity under the Quarriable Substances Act, i.e., the land owner has the rights to the material, and the consequential limited reporting requirements.

Presently, the L.E. Shaw Company is the Province's major producer of clay and brick shale. Their plant in Chipman uses shale from a quarry about 3 km away which has operated since 1935. The company established the brick plant in the area in 1929 to use waste shale from the coal mines in the area. Although headquartered in Nova Scotia, the company's association with New Brunswick dates back many decades. The Great Saint John Fire of 1877 helped solidify the business due to the surge of orders which resulted as residents of the city opted to rebuild with a nonflammable material instead of the traditional wood. The Chipman plant currently produces brick, flue liners, and a variety of tile products.

Expanded shale for lightweight aggregate is also produced in New Brunswick. Avon Aggregates Ltd, a division of Modern Enterprises, operates a facility in the Minto area. A porous shale is used as the raw material. The shale overlies the coal seam in the area, but at the plant location the coal was underground mined in the 1930s. The shale is crushed and fed into a 40 foot rotary kiln. The kiln is coal-fired and operates

at a temperature of about 2000°F. Thermal decomposition of the shale releases gases including carbon dioxide and water vapour and causes a "popping" of the shale to produce the lightweight aggregate material. The material is then crushed and screened to the desired size fractions. The material is used in a variety of products and can replace conventional aggregates in most applications. It weighs about 60 percent of conventional aggregates but has high hardness and abrasion resistance characteristics.

The plant has operated on an as-required basis since 1971. Because of high energy costs and time factors to reach and maintain the operating temperature, the plant operates on a 24 hour basis when in production. Material is stockpiled to meet anticipated demand. Selling price is in the order of $50/tonne F.O.B. the Minto plant. The material is sold primarily in the Maritimes and Quebec. Markets in the US have declined since the opening of a similar facility in New York State. Winnipeg also has a facility which produces a comparable product. Potential markets for the commodity include offshore oil developments and the proposed fixed link crossing to PEI.

Lafarge Canada Inc., (formerly Canada Cement Lafarge Ltd.) plant at Havelock also has been a producer of shale for use in cement manufacture. The shale is added to maintain the required calcium/silica/alumina ratio for the cement. However, the cement operation was closed in 1987 pending market improvement.

Since the production of clay and shale has been essentially "in-house" production for a specific use, reliable statistics on production are not available. However, Table 1 displays the value of clay products and gives an indication of the magnitude of the industry.

TABLE 1

NEW BRUNSWICK CLAY PRODUCTS PRODUCTION* (C8, C9)
1946-1987

Year	Current Dollars (Thousands)	1987 Dollars (Thousands)
1946	$ 337	$2 459
1947	N/A	
1948	N/A	
1949	N/A	
1950	N/A	
1951	741	3 682
1952	N/A	
1953	N/A	
1954	N/A	
1955	N/A	
1956	976	4 682
1957	N/A	
1958	630	2 855
1959	744	3 328
1960	705	3 113
1961	744	3 264
1962	822	3 562
1963	623	2 649
1964	698	2 915
1965	668	2 724
1966	619	2 438
1967	567	2 154
1968	630	2 299
1969	585	2 043
1970	940	3 179
1971	627	2 060
1972	668	2 095
1973	840	2 448
1974	1 131	2 970
1975	1 310	3 105
1976	2 464	5 431
1977	1 989	4 062
1978	2 306	4 327
1979	2 500	4 295
1980	2 667	4 159
1981	1 415	1 962
1982	2 200	2 753
1983	3 200	3 786
1984	3 313	3 756
1985	4 153	4 527
1986	3 026	3 147
1987	2 850 P	2 850

*production quantity (tonnes) data not available

P - preliminary

3.0 CONSUMPTION

Uses and quantities. In 1986 brick manufacturing in Canada accounted for 84 percent of product output for domestic (versus imported) clay. Flue lining accounted for 4.5 percent of output and drain tile 1.9 percent. (C1)

Clay consumption for the United States is presented in Table 2. (C2) The most significant uses were face brick (39.4 percent), Portland and other cements (28.5 percent), common brick (13.4 percent), lightweight aggregate (12.2 percent) and vitrified sewer pipe (1.9 percent). See Figure 1.

3.1 Brick, Tiles and Other Construction Materials

Description. Bricks have been used for thousands of years and must rank as one of mankind's greatest inventions. The first mass-produced construction material, bricks are uniform modules which are small, easy to handle yet hard, strong and durable.

To make good brick, producers require clays which are easy to mold and have good drying and firing properties. Among minerals added to clays to improve firing are silica and feldspar. There are four main processes involved in brick production:

1) extraction and preparation of raw material;
2) shaping or forming;
3) drying and firing; and
4) inspection and packaging. (C3)

For this report the term brick will include building bricks and facing bricks.

TABLE 2

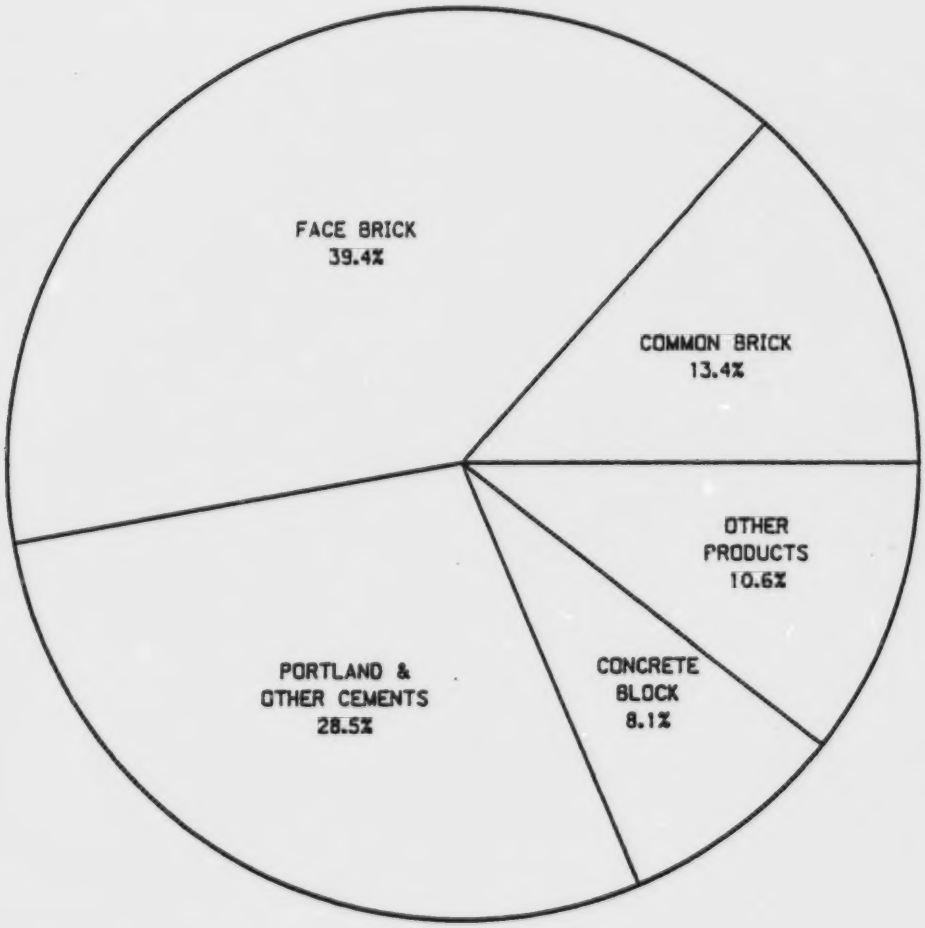
COMMON CLAY AND SHALE SOLD OR USED BY PRODUCERS IN THE UNITED STATES IN 1986, (C2)

Use	Quantity tonnes (M)	Quantity %
Absorbent:		
- oil and grease	W	
- pet waste	W	
- other (including above)	0.125	0.5
Ceramics and glass:		
- crockery and other earthenware	0.010	**
- electrical porcelain	*	**
- pottery	0.008	**
- roofing granules	0.094	0.3
- other	0.001	**
Civil engineering and sealing	0.073	0.3
Fillers, extenders, binders:		
- animal feed	*	**
- paint	*	**
- pesticides and related products	0.004	**
- rubber	0.007	**
- other	0.017	0.1
Floor and wall tile:		
- ceramic	0.088	0.3
- quarry tile	0.187	0.7
- other	0.001	**
Heavy clay products:		
- brick, common	3.645	13.4
- brick, face	10.726	39.4
- drain tile	0.043	0.1
- flower pots	0.036	0.1
- flue linings	0.039	0.1
- Portland and other cements	7.777	28.5
- roofing tile	0.006	**
- sewer pipe, vitrified	0.514	1.9
- structural tile	0.025	0.1
- terra cotta	0.001	**
- other	0.106	0.4
Lightweight aggregate:		
- concrete block	2.206	8.1
- highway surfacing	0.177	0.6
- structural concrete	0.911	3.3
- other	0.057	0.2
Refractories:		
- firebrick, blocks and shapes	0.128	0.5
- mortar and cement, refractory	0.220	0.8
Exports	0.020	0.1
Total	27.254	100.0

* less than 0.001 tonnes (M)
**less than 0.1%

FIGURE 1

COMMON CLAY AND SHALE SOLD OR USED BY PRODUCERS
IN THE UNITED STATES IN 1986 (C2)



Tiles have a history as old as brick and made with the same materials and, often, by the same companies. Tiles include drainage tiles, roofing tiles, structural tiles, partition tiles and terra cotta.

Other construction materials include sewer pipes and flue linings.

Companies and locations/sources and suppliers. Table 3 presents information on major brick and tile producers within 800 kilometres of New Brunswick. For the most part the brick industry is vertically integrated: the producers mine their own clay and produce their brick and tile on or near the mine site. Brick clay is rarely transported very far--according to the United States Bureau of Mines and Minerals "The economic radius for shipment of common clay or shale products is usually 200 miles or less." Thus the radius for the raw material would be even smaller. (C4)

Specifications. Common clay does not have the rigorous specifications of the specialty clays (fire clay, ball clay, kaolin, etc.) and there are no recognized grades for it. However, brick manufacturers have specifications relating to such things as drying and firing properties, and silica content. (C3) (See Table 4.)

Prices. Values for common clay and shale mined in the northeastern United States are presented in Table 5. Values ranged from $2.85 to $22.00 per tonne (f.o.b. mine or plant) in 1986 with most production valued around $7.00 to $10.00.

Canadian values were not available.

Presented in Table 6 are prices paid for structural clay products in several large cities within 800 kilometres of New Brunswick. In 1986 the average American prices were:

TABLE 3

CHARACTERISTICS OF CLAY PRODUCERS AND CONSUMERS
WITHIN 800 KILOMETRES OF NEW BRUNSWICK (C1, C2 TRADE DIRECTORIES)

Province/State	Name	Size*	Location	Raw Material	Products	Notes
New Brunswick	Avon Aggregates	01	Minto	shale	expanded aggregate	supplies Atlantic Canada and New England
	L. E. Shaw Limited	04	Chipman	shale	facing brick, tiles, drainage and partition	
	Lafarge Canada Inc.	02	Havelock	shale	portland cement, cement	Plant closed in 1987; however, is prepared to reopen pending market improvement.
Newfoundland	Trinity Brick Products Limited	01	St. John's	shale	building bricks	
Nova Scotia	L. E. Shaw Limited	04	Lantz	common clay, ball clay	brick, block and tile	
Quebec	Bricade Estrielle Inc.	01	Westbury	common clay	facing brick	
	Canada Brick Co. (Div. of Laprairie)	01	Laprairie	shale	building brick and facing brick	bought from Domtar Inc. in 1985
	Citadel Brick Ltd. Div. of Brampton Brick Limited	02	Beauport	shale	building brick drain tile and flue lining	sold to Brampton Brick in 1986
	Montreal Terra-Cotta Inc.	01	Deschaillons	shale, common clay	building brick, tile and flue lining	

*see end of table for size codes

TABLE 3 (continued)

Province/State	Name	Size	Location	Raw Material	Products	Notes
Quebec (continued)	St. Lawrence Brick Co. Limited	02	Laprairie	shale	building brick	
Ontario	Amos C. Martin Limited	01	Parkhill Wallenstein	shale	drain tile	
	Brampton Brick Limited					
	Brampton Div.	02	Brampton	shale	building brick	
	Toronto Div.	03	Toronto	shale	building brick	bought from United Ceramics Limited in 1985
	Canada Brick Co.	04				
	Burlington Div.		Burlington	shale	building brick	new plant in construction
	Burlington Div.		Burlington	shale	building brick	
	F.B. McFarren Div.		Streetsville	shale	building brick	
	Mississauga Div.		Mississauga	shale	building brick	bought from Domtar Inc. in 1985
	Ottawa Div.		Ottawa	shale	building brick	
	Streetsville Div.		Streetsville	shale	building brick	
	Dochart Clay Products Co. Ltd.	01	Arnprior	common clay	tile	
	Dresden Tile Yard (1981) Limited	01	Dresden	shale	building brick, tile and flue lining	
	George Coultis & Son Limited	01	Thedford	shale	tile, drain tile	
	St. Mary's Cement Limited		Woodstock	clay	cement	

TABLE 3 (continued)

Province/State	Name	Size	Location	Raw Material	Products	Notes
Ontario (continued)						
	St. Mary's Cement Limited	03	St. Mary's	clay	cement	
	Halton Ceramics	01	Burlington	common clay and shale	block and tile	
	Hamilton Brick	01	Hamilton	shale	building brick	
	National Sewer Pipe Limited	01	Oakville	shale and fire clay	flue lining and sewer pipe	
Maine	LaChance Brick Co.	01	Gorham	clay	brick	a division of Morin Brick Co.
	Dennis Brick Co. Inc.	01	Auburn	clay	brick	
	Morin Brick Co.	03	Auburn	clay	brick	
	Royal River Brick Co.	01	Gray	clay	brick	
New Hampshire	Kane-Gonic Brick Corp.	01	Rochester	clay	brick	80% of production shipped to Boston for restoration projects
Massachusetts	K-F Brick Co. Inc.	02	Middleborough	clay	facing brick	
	New England Brick Co.	01	Reading	clay	brick, tile	
	Masslite, Division of Lorusso Corp.	01	Walpole	clay shale	lightweight aggregate	
	Stiles & Hart Brick Co.	02	Bridgewater	clay	brick, tile	

TABLE 3 (continued)

Province/State	Name	Size	Location	Raw Material	Products	Notes
Connecticut	Clay Products Inc.	01	East Windsor	clay	brick, tile	
	The Michael Kane Brick Co.	01	Middletown	clay shale	brick	used traprock in lieu of shale in 1985, uses coal for fuel
	K-F Brick Co.	03	East Windsor Hill	clay shale	brick	
New York	Atlantic Cement Co. Inc.	unknown	Albany Co.	clay shale	cement brick	
	Jova Manufacturing	02	Kingston	clay	brick	
	Norlite Corp. a subsidiary of P.J. Keating Co.	unknown	Cohoes	shale	brick	
	Northeast Solite Corp.	unknown	Ulster Co.	clay, shale	lightweight aggregate, brick	
	Powell & Minnock Inc.	unknown	Coeymans	clay shale	lightweight aggregate, brick	
New Jersey	Almase Clay Co.	unknown	Woodbridge	clay	brick, pipe	
	New Jersey Shale Brick & Tile Corp.	02	Somerville	clay	brick, tile	
Pennsylvania	Glen-Gery Co.	04	Reading	clay	brick	
	Hanley Brick Inc.	04	Summerville	clay	brick, tile	
	McAvoy Vitrified Brick Co.	02	Phoenixville	clay, shale	facing brick, paving brick, common brick	

TABLE 3 (continued)

Province/State	Name	Size	Location	Raw Material	Products	Notes
Pennsylvania (continued)	Watsontown Brick Co.	01	Watsontown	clay, shale	facing brick, building brick	

Summary statement for Table 3

Canada:

- clay produced by 3 companies
- common clay produced by 5 companies
- shale produced by 22 companies

United States:

- clay produced by 17 companies
- shale produced by 9 companies

Size Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

TABLE 4

SPECIFICATIONS RELATING TO BRICK AND TILE (C3)

Specification	Title
CSA A82.1M	Burned Clay Brick
CSA A82.2M	Methods of Sampling and Testing Brick
CSA A82.4M	Specification for Structural Clay Load Bearing Wall Tile
CSA A82.5M	Structural Clay Non-load Bearing Tile
CSA A82.6M	Standard Method for Sampling and Testing Structural Clay Tile
CSA A82.8M	Hollow Clay Brick
CSA A179M	Mortar and Grout for Unit Masonry
CSA S304M	Masonry Design and Construction for Buildings (NBC 1977 Code for Masonry Design)
ASTM C4	Clay Drain Tile
ASTM C498	Clay Drain Tile

TABLE 5

VALUE ($CDN/TONNE)* OF COMMON CLAY AND SHALE
SOLD OR USED BY PRODUCERS IN THE
NORTHEASTERN UNITED STATES (1983-1986)
(C2, C5, C6)

State	1983	1984	1985	1986
Maine	$ 3.10	$ 3.25	$ 2.95	$ 2.85
Massachusetts	8.00	7.40	7.70	9.15
Connecticut	8.80	8.35	8.75	9.15
New York	3.45	6.55	6.55	7.30
New Jersey	11.30	11.73	22.00	22.00
Pennsylvania	5.95	6.10	6.25	5.30

*Canadian dollars. $Cdn = $0.75 US

TABLE 6

PRICES (IN CANADIAN DOLLARS)* PAID FOR STRUCTURAL CLAY PRODUCTS
IN CITIES WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(C7)

Product	City	1986				1987			
		January	April	July	October	January	April	July	October
Structural Clay Tile - partition - 4 x 12 x 12 inch - per thousand	Boston	$2530	$2600	$2600	$2600	$2600	$2787	$2787	$2787
Structural Clay Tile - loadbearing - 8 x 12 x 12 inch - per thousand	Boston	4800	4800	4800	4800	4800	5200	5200	5200
Brick - common backing - per thousand	Montreal	150	90	90	90	95	95	95	95
	Toronto	190	215	215	215	-	-	-	235
	Boston	360	360	360	360	360	363	363	363
	New York	176	176	176	176	176	176	200	200
	Philadelphia	347	347	347	347	347	333	333	333
	Baltimore	2130	227	227	227	227	247	247	247
Brick - straight hard - per thousand	Montreal	275	275	275	275	289	289	-	289
	Toronto	-	-	-	-	-	-	-	-
	Boston	360	360	360	360	360	363	363	363
	New York	294	294	294	294	294	294	323	323
	Philadelphia	347	347	347	347	347	360	380	380
	Baltimore	-	-	-	-	-	-	-	-

*$1 Cdn = $0.75 US

unglazed common and face brick	$0.18/brick
unglazed structural tile	0.52/tile
vitrified clay and sewer pipe fittings	0.30/tile
clay floor and wall tile	1.60/tile

Substitutes. There is only one economic substitute for clay/shale in bricks and tile and that is concrete. Common clay and shale are plentiful, easy to mine, easy to use and relatively inexpensive. However, concrete is also inexpensive and the quality of concrete bricks has improved significantly in recent years. (C3)

There are substitutes for brick and tile. Glass, steel, aluminum, plastic, wood, gypsum, concrete, stucco and other materials have been used in place of brick in building construction. Tile competes with asphalt shingles and aluminum in roofing; wood, linoleum, and plastic in flooring; concrete, fibreglass, glass, and stainless steel in pools, kitchens, and bathrooms; polyvinyl chloride (PVC) and concrete in piping. While all the substitutes have reduced somewhat the market share held by brick and tile, these clay and shale products have maintained and should continue to maintain a significant market share.

3.2 Lightweight Aggregate

Description. A relatively recent use of shale and clay is for lightweight aggregate. This material is used to reduce the weight of concrete for large structures such as bridges, high rise buildings, and large, low rise buildings with long spans. Another use is in top course asphalt where lightweight aggregate has superior skid resistance to regular aggregates.

Lightweight aggregate from clay or shale requires the formation of gas at the heat of fusion, the gas is then encapsulated by the glass produced in clay or shale at fusion temperature. The gas remains trapped as the material is cooled resulting in a material with expanded volume and lower density than the original clay or shale. (C3)

The aggregate is produced by four processes:

1) quarrying;
2) raw material separation;
3) firing; and
4) preparation of material to size. (C3)

Companies and locations/sources and suppliers. Producers of lightweight aggregate and their suppliers of clay and shale are presented in Table 3.

Specifications. There are no standard specifications for clay or shale used for lightweight aggregate. Specifications for the aggregate itself include CSA CAN-A23.1-M77 and ASTM C330-77.

Prices.

The values of lightweight aggregate in the United States for the 1983-1986 period were:

1983	$10.15/tonne
1984	$11.15/tonne
1985	$ 8.95/tonne
1986	$16.95/tonne

Higher prices are sometimes experienced in local market areas - $50.00 per tonne in New Brunswick in 1988, for example.

Substitutes. Lightweight aggregate is itself a substitute for gravel and crushed stone and competes with those materials. However, because of its higher cost and special properties, it has a segment of the construction industry to itself. There are lightweight aggregates other than expanded clay and shale which compete with them: pumice, expanded slag, expanded vermiculite and sintered fly ash. The high cost of fuel through the 1970s and 1980s hurt the expanded aggregate market.

3.3 Cement

Description. Common clay and shale are used as low-cost sources of alumina and silica for portland cement manufacture and are added to maintain the necessary mix of calcium, silica and alumina. In 1986, the cement industry consumed almost 30 percent of the common clay and shale produced in the United States. The quantity of material consumed in Canada is unknown, but significant. Assuming that clay represents 10 percent of the cement mix, consumption was approximately 1.0 M tonnes in 1986.

Companies and locations/sources and suppliers. Cement plants which mine and use clay are listed in Table 3.

Specifications. There are no specifications for clay and shale used for cement production. The clay or shale is part of the cement clinker mix and are added to supply alumina and silica. Thus, once the composition of the clay or shale and the requirements of the mix are known, clay (or shale) is added to suit. There are specifications (ASTM, CSA) for cement, however.

Prices. Table 5 presents values for common clay and shale mined in the northeastern United States. These figures would apply to clay used for cement as well as for brick.

Substitutes. While other materials can be used to supply alumina and silica (silica sand, pozzolanic minerals), clay and shale are among the cheapest and most readiliy available. Thus, they should continue to be used in large quantities.

3.4 Consumption Estimates

Brick, tiles and other construction materials. The market area for these products is usually 300 kilometres. Thus, the New Brunswick market is served mainly by products manufactured at the L.E. Shaw Limited plant in Chipman wich some products coming from Shaw's plant in Lantz, Nova Scotia.

Consumption, therefore, leads local production of bricks, tiles and other construction products and can be estimated from production figures. Thus in the 1980s, the value of consumption has ranged from $2.0 M to $4.5 M.

Assuming a product mixture of 80 percent bricks, 15 percent flue linings, and 5 percent tile, the production values are:

$1.6 - 3.6 M brick
0.3 - 0.7 M flue linings
0.1 - 0.02 M tile

In 1988, bricks sold at $500 per thousand (delivered) and flue linings at $28 each. Assuming production values of $400 per thousand for brick and $22 each for flue linings, brick production has ranged 400 000 - 900 000 bricks per year and flue linings 14 000 - 32 000 per year.

4.0 BIBLIOGRAPHY (COMMON CLAY/BRICK SHALE/EXPANDED SHALE)

C 1 Prud'Homme, M. "Clays and Clay Products." Publication, from Canadian Minerals Yearbook, 1986, Review and Outlook, Ottawa, Ont.: Canadian Government Publishing Centre, 1987.

C 2 Ampian, Sarkis, G. "Clays." Preprint, from 1986 Bureau of Mines Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1987.

C 3 Guillet, G.R., and Joyce, I.H. The Clay and Shale Industries of Ontario, Toronto, Ont.: Ontario Ministry of Natural Resources, Queens Printer for Ontario, 1987.

C 4 Ampian, Sarkis G. "Clays." Preprint, from Bulletin 675, Mineral Facts and Problems, 1985 Edition.

C 5 Ampian, Sarkis G. "Clays." 1985 Bureau of Mines Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1986.

C 6 Ampian, Sarkis, G. "Clays." Preprint, from 1984 Bureau of Mines Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1985.

C 7 "Market Prices." ENR, The McGraw Hill Construction Weekly, January 1986 - October 1987.

C 8 Chandra, James J. "Mineral Production Statistics 1899-1985 New Brunswick." New Brunswick Department of Forest, Mines and Energy, Mineral Resources Division, Open File Report 86-2, 1986.

C 9 "L.E. Shaw Ltd. Builds Empire Brick by Brick." The Brunswick Business Journal, Sept. 1987. p. 23.

C 11 Greig, E.W. "Report on Clay and Shale Deposits of New Brunswick." New Brunswick Mineral Resources Division, Reference Report 6, 1943.

C 12 Leveille, J. "Inventory of Clay Deposits of New Brunswick." New Brunswick Resources Division, Open File Report 77-9, 1977.

DIMENSION STONE

D I M E N S I O N S T O N E

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	78
2.0	PRODUCTION STATUS IN NEW BRUNSWICK	80
3.0	CONSUMPTION	88
	3.1 Monuments	88
	3.2 Building Stone	103
	3.3 Curbing	107
4.0	BIBLIOGRAPHY	109

D I M E N S I O N S T O N E

LIST OF TABLES

		Page
TABLE 1	PRINCIPAL SANDSTONE QUARRY REGIONS IN NEW BRUNSWICK	81
TABLE 2	PRINCIPAL GRANITE QUARRY REGIONS IN NEW BRUNSWICK	83
TABLE 3	CONSUMPTION OF DIMENSION STONE IN CANADA BY USE AND TYPE, 1985	90
TABLE 4	CONSUMPTION OF DIMENSION STONE IN THE UNITED STATES BY USE AND TYPE, 1985	91
TABLE 5	LARGE SUPPLIERS OF MONUMENTS WITHIN 800 KILOMETRES OF NEW BRUNSWICK	93
TABLE 6	MAJOR PRODUCERS OF DIMENSION STONE WITHIN 800 KILOMETRES OF NEW BRUNSWICK	97
TABLE 7	VALUE OF DIMENSION STONE SOLD OR USED BY PRODUCERS IN THE UNITED STATES, 1985	106
TABLE 8	SPECIFICATIONS OF THE AMERICAN SOCIETY FOR TESTING AND MATERIALS WHICH PERTAIN TO BUILDING STONE	108

LIST OF FIGURES

		Page
FIGURE 1	CANADIAN CONSUMPTION OF DIMENSION STONE BY USE, 1985	89

DIMENSION STONE

1.0 INTRODUCTION

Definition. The term dimension stone traditionally has included building stone, monumental stone, ornamental stone, paving blocks, curbstone, slate, and flagstone; and a variety of specialized uses such as grindstones and curling stones. More recent products generally included in the term include stone slabs and panels for building cladding and sidewalks; and landscaping and streetscaping applications such as lamp posts, planters, benches, bollards and related fixtures. The term dimension stone implies that some form of shaping or dimensioning is required. This finishing or fabrication phase can involve sawing, grinding, honing, polishing, carving, turning, chiselling, thermal treatment, and related techniques. Certain dimension stones can be produced with a rough or split face. The fabrication plant is often separate from the quarry operation and may use stone from several quarries including out-of-province and imported sources.

The term "rough stone" is applied to "unfinished" blocks of quarried material. This term includes stone quarried for riprap (breakwaters, etc.), rubble (unsquared blocks) and in masonry walls and foundations, and crushed stone. These commodities have not been considered in the present study.

Several rock types are used for building stone. The most common types are: limestone, marble, granite, and sandstone.

Special properties. Dimension stone has several properties which make it a desirable building material:

1. Aesthetics - Dimension stone has a variety and richness of colour and texture which is not found in many materials.

2. Durability - Some rock types such as granite are extremely durable and resist damage from traffic, rock salt, air pollution and other environmental conditions.

3. Weight - For several applications such as monuments, the weight of stone is a desirable property.

4. Strength - New technology allows for the production of thin sheets of stone for wall panels and veneers, the strength of stone is such that thin sheets are still strong enough to resist wind and other loads.

5. Cost - Because of the above properties, dimension stone is often cost competitive with other building products of comparable quality. Granite curbs, for example, are more durable than concrete curbs and have a lower life-cycle cost.

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

The use of stone in New Brunswick dates back to the earliest settlers. A red granite medallion found in the St. George area in 1862 shows the head of an Indian Chief. The medallion, now in the museum in Saint John, is believed to have been crafted by a stonecutter who was part of the Demont and Champlain expedition of 1604 to commemorate their visit to the region. (DS 5)

Buildings constructed from stone was a traditional practise for European settlers. Despite the abundance of lumber for buildings in the Province, stone was frequently selected as a construction material. In particular, "public" buildings such as churches, post offices and similar structures tended to be constructed from stone.

There are several categories or groups of dimension stone. Sandstone and granite are the principal types which have historically been produced in the Province, whereas materials such as limestone and marble are typically imported. This production preference reflects the geology of the Province and the availability of various types of bedrock.

Sandstone quarries have been concentrated in the eastern portion of the Province. A classic 1914 report by Parks (DS 7) describes in considerable detail the characteristics of numerous sandstone quarries in each of several regions (see Table 1). The report also discusses examples of the use of stone from the various quarries and provides photographs of many buildings, etc. Many of the quarries were located on the coast where stone was frequently shipped by sea. In addition to the numerous buildings in the Maritimes constructed from sandstone, New Brunswick stone has been used in Montreal, Hamilton, Ottawa, Toronto, and Boston.

TABLE 1

PRINCIPAL SANDSTONE QUARRY REGIONS IN NEW BRUNSWICK

Region/Quarry	Stone Colour	Example of Use
Chaleur Bay		
Clifton, Stonehaven, New Bandon	grey	grindstones
Grand Anse		post office, Bathurst church, Caraquet
Miramichi		
Quarryville (Indiantown)	olive green	post office, Campbellton
Hill (Newcastle)	olive green	hospital, Chatham
French Fort Cove	olive green	Langevin Block, Ottawa
Bouctouche		
Bouctouche	olive green	
Notre Dame (Cocagne)	olive green	YMCA, Moncton
Shediac		
Smith	olive green	Moncton High School (1988 addition)
Cape Bald (Cap Pele)	brown	
Baie Verte	green brown	
Fredericton		
Three Tree Creek (Fredericton Jct)	grey (and dark purple)	Departmental Building, Fredericton
Salmon River	grey	
Shepody Bay		
Mary's Point	grey and red	Provincial Building, Halifax
Demoiselle Creek	olive green (yellow brown)	
Rockland	olive green to blue grey	
Cumberland Bay		
Sackville	red	bank, Moncton; Mount Allison University
Wood Point	grey brown	grindstones
Rockport	olive green (grey)	Railway station, Sackville

Note: Some of the buildings listed above may no longer be used for their original purpose.

Granite quarries have also been concentrated in certain regions of the Province, again reflecting the nature of the bedrock geology (see Table 2). The Charlotte County region has traditionally been regarded as the center of the granite industry in the Province (and in the Maritimes). Quarrying began in the St. George area in 1872 (DS 7) By 1875, 100 men were employed 9 to 11 months per year by three companies. (DS 6) Employment exceeding 60 persons (presumably full-time) was also reported for 1898, 1931, and 1932. Employment figures of 300 (DS 6) and 500 persons (DS 5) have also been reported for the region. In 1911, five firms operated mills in St. George and finished both "local" stone and material brought from the Bocabec and Spoon Island areas and some imported stone. However, the St. George quarries tended to extract stone solely for their own finishing plants and sales of "rough" stone were often infrequent. Import duties on finished stone for the US market, higher freight rates to central Canada for finished stone relative to rough stone, and competition from imported stone finished at other locations were factors which limited the industry. In 1932 four companies were operating in the region. (DS 6) Over four dozen quarries had been opened, although many were small and were abandoned when unfavourable rock characteristics were encountered. The distinctive red granite of the St. George area is perhaps the best known product of the region, but black, grey and pink material was also produced in the Bocabec and St. Stephen areas.

In the Saint John region, granite quarries near Spoon Island are among the best known. Both a pink and grey blue granite have been produced. In the Bathurst region the light pink Antinouri Lake granite and the greyer stone from Pabineau have been used in numerous buildings including a large church at Petit Rocher (built in 1887-90) and at several locations in Bathurst. In the Fredericton-Woodstock region there apparently was an operating

TABLE 2

PRINCIPAL GRANITE QUARRY REGIONS IN NEW BRUNSWICK

Region/Quarry	Stone Colour	Example of Use
Bathurst		
Antinouri Lake	pink (rose)	church, Petit Rocher
Pabineau	pink (light grey)	courthouse, Bathurst
Charlotte County		
Ledge Road	grey	
Bocabec District	black	exterior of Centennial Building, Fredericton and pillars, Justice Building, Fredericton
St. George	red	
Lily Lake	salmon	
Dawson Mountain	pink	entrance to Saint Joseph Regional Hospital
Fredericton-Woodstock		
Pokiok	grey	
Saint John		
Spoon Island (Hampstead)	pink and grey (blue)	curbing, bollards, planters in downtown Moncton

quarry at Pokiok; however, this was flooded by Mactaquac Hydro-electric Development. Large boulders have been collected in the Macadam area and finished into building stones. Some of these may have been used in the train station in MacAdam.

The history of the stone industry in the Province appears to have limited documentation which is readily accessible. The sandstone side of the industry is assumed to have developed earliest. One of the province's two existing quarry operators, Smith Cut Stone and Quarries Limited of Shediac, was established in 1818 and has been controlled by family members since that time. The granite industry appears to have first operated in 1872. The stone industry initially had a close relationship to the construction industry, although some stone has been used for monumental purposes.

Early construction practices reveal that exterior building walls were load bearing and the base course therefore had to support the entire weight of the structure. However, increased use of structural steel and reinforced concrete led to a decline in the requirement for stone. In cities the appearance of the upper storeys of large buildings was not important because grime often covered the exterior. A stone veneer or face brick could be used to cover the lower 1 to 2 storeys to improve the appearance for passerbys but the remainder was not visible. In brick buildings, base courses, steps, window sills and lintels and corner blocks could be made of stone for appearance but overall use gradually declined. High costs associated with the quarrying and finishing of the stone probably contributed to its apparent demise.

The period prior to 1920 probably was the most active for the industry in the Province. Production in 1921 was 14 000 tons, declining to 9000 tons by 1925. Between 1925 and 1950 production was below 6000 tons (except two years 1930, 46 000 tons,

and 1935, 31 000 tons) and dropped to only 358 tons in 1946. (DS 8) Recent statistics on quarry output in the Province are limited since the output typically is grouped with crushed stone production from aggregate quarries.

With a decline in stone use related to changes in construction practises, the market for stone products became almost exclusively centered around memorial stone. Although some curb-stone and bridge construction materials were produced, concrete was often the favoured material. More recently architectural trends and tastes have changed and there has been a resurgence in the stone industry. (DS 4) (DS 9) New production techniques permit thin (1½ inch) stone panels to be produced. New fastening techniques and prefabrication approaches have reduced installation costs. Much of the stone has been imported but North American finishing plants, particularly in Quebec, have now been equipped to complete the work and more native stone is being employed. Quarrying techniques have also progressed and new blasting techniques and flame cutting technology are employed. Provision of stone for restoration, particularly sandstone, also appears to be a growing trend that will ultimately require additional production.

The use of granite as curbing in bridges has been practised extensively in New Brunswick for the past decade. Resistance to salt and to physical damage from snow removal equipment are the principal factors involved. The use of granite curbing for city streets is also increasing. Life cycle costing indicates that while the initial installation costs are slightly higher, the long-term maintenance costs are lower. Thus the use of granite curbing can be based on economic rather than aesthetic criteria.

At present, there are two companies in the Province who operate quarries. These companies, and two additional firms, have various levels of stone fabrication and finishing capabilities.

Smith Cut Stone and Quarries Limited is located in Shediac. The company was established in 1818 and has been family-controlled since that time. Olive-green sandstone is quarried at the company's Shediac location. A red sandstone quarry has been operated in the Sackville area. These quarries operate on a demand basis. The fabrication plant is equipped with a gang saw, diamond saws, planers, polishers and a variety of associated equipment. Stone for numerous buildings has been processed by this operation such as the New Brunswick Museum in Saint John, the Cathedral in Moncton, and various buildings at Mount Allison University.

Stone pillars and carved ornamental stone have also been produced. The finishing plant also uses out-of-province stone or finishes stone on a contract basis.

Nelson Monuments Ltd., headquartered in Sussex, is the largest company of its kind in the Maritimes. The company was formed in 1909 and has remained in the control of various family members since that time. The firm initially was located in the Hopewell Cape area of Albert County but erected new facilities in Sussex in 1959. The company produced some sandstone in the early years but concentrates on granite. The firm presently owns several granite quarries in the southern part of the Province including Spoon Island, Dawson Mountain, and Digdeguash Lake and operate them on a demand basis. The Spoon Island quarry is the most active.

Nelson's principal product is memorial stone. A large percentage of these use imported stone. Bases for memorial stones, curbing stone, and a variety of other custom-made products are also manufactured. The company's plant is equipped with a 3.5 m diameter diamond saw, smaller diamond saws, polishers, drills and corers, flame treatment equipment, blasting and lettering facilities, and related equipment.

Smet Monuments of St. Stephen produces granite monuments, bases and markers. The plant is equipped with polishing and finishing equipment and blasting and lettering facilities. Mainly imported stone is used.

Dupuis Cut Stone Ltd. of Shediac has automated diamond saws and ornamental stone manufacturing facilities at their plant. They have produced sandstone products for building construction (Moncton High School addition, Parliament Buildings, Ottawa) and are producing stone planters, etc., for ornamental and landscape purposes.

3.0 CONSUMPTION

Use and quantities. In 1985 the reported consumption of dimension stone by use in Canada was (DS 1) (see Figure 1):

rough	0.280 tonnes (M)
monumental and ornamental stone	0.058 tonnes (M)
other (flagstone, curbstone, paving, etc.)	0.025 tonnes (M)

Consumption by stone type is shown in Table 3.

(There was no Canadian review of dimension stone in 1986.)

Consumption for the United States in 1985 is presented in Table 4.

For this report most rough stone categories will not be discussed except for monumental uses.

3.1 Monuments

Description. Most monumental stone is used for tombstones with smaller amounts for cairns, cenotaphs, and historical monuments. In the United States tombstones share the memorial market with bronze markers. It is estimated that there are 2.3 million funerals in the United States each year resulting in 0.9 million bronze markers (39 percent) and 0.57 million (25 percent) tombstones being used. In turn, most bronze markers (an estimated 80 percent) use granite bases. (DS 3) In Canada, there are about 230 000 funerals each year. Bronze markers are not commonly used in Canada, likely 60 percent or more of all memorials are stone.

FIGURE 1

CANADIAN CONSUMPTION OF
DIMENSION STONE BY USE
1985 (DSI)

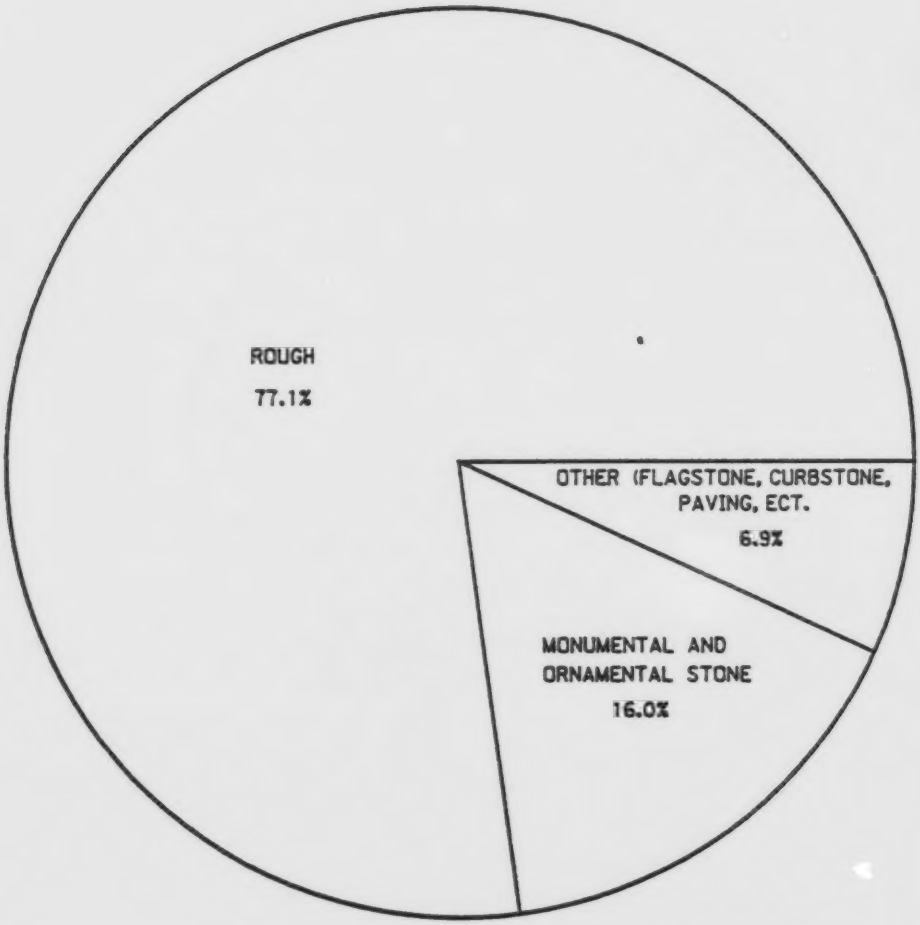


TABLE 3

CONSUMPTION OF DIMENSION STONE IN CANADA
BY USE AND TYPE, 1985 (DS 1)

Use	Stone Type (Tonnes (m))				
	Limestone	Marble	Granite	Sandstone	Total
Rough	0.179	0.018	0.057	0.026	0.280
Monumental and ornamental stone	0.001	0.005	0.038	0.015	0.059
Other (flagstone, curbstone, paving, etc.)	0.014	0	0.009	0.002	0.025
TOTAL	0.194	0.023	0.104	0.043	0.364

TABLE 4

CONSUMPTION OF DIMENSION STONE IN THE UNITED STATES BY USE AND TYPE, 1985 (DS 2)

Use	Stone Type (Tonnes (m))						
	Granite	Limestone	Marble	Sandstone	Slate	Total Quantity	Total %
Rough stone:							
rough block for building and construction	0.096	0.119	0.003	0.014	--	0.233	23.5
irregular-shaped stone[1]	0.051	0.034	W	0.050	--	0.135	13.6
monumental	0.204	--	--	--	--	0.204	20.6
other[2]	0.001	0.001	0.007	0.004	--	0.013	1.3
Dressed stone:							
ashlar[3] and partially squared pieces	0.029	0.058	--	0.027	--	0.114	11.5
slabs and blocks for building and construction	0.034	0.035	0.009	0.007	--	0.085	8.6
monumental	0.044	0.002	--	--	--	0.046	4.6
curbing	0.080	0.001	--	--	--	0.081	8.1
flagging	--	--	--	0.007	0.014	0.021	2.1
roofing slate	--	--	--	--	0.011	0.011	1.1
structural and sanitary	--	--	--	--	0.005	0.005	0.5
flooring slate	--	--	--	--	0.006	0.006	0.6
other	0.011	0.006	0.013	0.006	--	0.036	3.8
TOTAL	0.551 (55.7%)	0.256 (25.9%)	0.031 (3.1%)	0.114 (11.5%)	0.037 (3.7%)	0.990 (100.0%)	100.0

1 includes rubble
2 includes flagging, other rough stone not listed and uses not specified
3 includes beneer
4 includes billiard tabletops, miscellaneous and uses not specified

Companies and locations. Monuments are distributed from the manufacturer to the buyer through three different channels:

i) full-service retail monument firms which have an inventory of monuments and, often, some production capabilities. In some cases these firms also have quarries.

ii) full-service retail firms which sell on a wholesale basis to cemetaries and funeral homes for resale.

iii) direct sale by manufacturers to cemeteries and funeral homes.

Table 5 lists the larger suppliers of memorials (and building stone) within 800 kilometres of New Brunswick.

Sources and suppliers. Table 6 lists major producers of dimension stone within 800 kilometres of New Brunswick.

Specifications. The primary specifications for monument stones are:

- appearance/colour;

- appearance/finish (and ability to take a polish);

- durability (marble is rarely used now as it is susceptable to chemical attack from air pollution and acid rain); and

- price (not a major factor as African sources are often used).

Price. Prices quoted in 1987 for rough granite purchased in the Atlantic Provinces were (DS 4):

TABLE 5

LARGE SUPPLIERS OF MONUMENTS
WITHIN 800 KILOMETRES OF NEW BRUNSWICK*
(TRADE DIRECTORIES)

State/Province	Company	Location	Size
New Brunswick	Brunswick Monuments Ltd.	Grand Falls	01
	Nelson Monuments Ltd.	Sussex	01
	Smet Monuments	St. Stephen	01
Newfoundland	Muirs Marble Works Ltd.	Mount Pearl	01
Nova Scotia	Arsenault Monumental Works Ltd.	Antigonish	01
	James M. Coughlan Monuments Ltd.	Windsor Junction	01
	Dauphinee Memorial Art (1984) Ltd.	Shelburne	01
	C. Demone's Monuments Ltd.	Lunenburg	01
	C. Demone's Monuments Ltd.	Lower Sackville	01
	Heritage Memorials Ltd.	Windsor	01
	S&R Lentz Memorials Ltd.	Shubenacadie	01
	David F. Steele Monuments Works	Sydney Mines	01
	John D. Steele's Sons Limited	North Sydney	01
	Tantallon Monument Works	Tantallon	01
	Tingley Monuments Ltd.	Amherst	01

*All suppliers are listed for New Brunswick, Newfoundland, Nova Scotia, and Prince Edward Island; for all other provinces only suppliers with over 20 employees are listed.

TABLE 5 (continued)

State/Province	Company	Location	Size
Prince Edward Island	Peters Monuments Limited	Summerside	01
Quebec	Adru Granite Inc.	Beebe	02
	Carrieres St-Marc Ltee	St-Marc-Des-Carrieres	01
	Dumas & Voyer Ltee	Riviere-A-Pierre	01
	Granite Buissiere Inc.	St-Sebastien	01
	Granite Dominion Ltee	Beebe	01
	Granite International Granite	Beebe	01
	Granit National Ltee	Alma	01
	Granite St-Gerard Inc.	St-Gerard	01
	Granits Frontenac (1979) Inc.	Lac Drolet	01
	St-Samuel Granit Enr.	Ste-Cecile-De-Whitton	01
Ontario	Kilvington Bros. Ltd.	Toronto	01
Maine	Riverside Drive Memorials	Augusta	N/A
Vermont	Anderson-Frigberg Co. Inc.	Barre City	01
	Associated Memorial Products Inc.	Barre City	01
	Beck & Beck Inc.	Barre City	02
	Bilodeau-Barre	Barre City	01

TABLE 5 (continued)

State/Province	Company	Location	Size
Vermont (cont'd)	Buttura & Sons Inc.	Barre City	01
	Centrangolo Finishing Works Inc.	Northfield	01
	Chioldi Granite Corp.	Barre City	01
	Cook Watkins & Patch Inc.	Barre City	02
	Desilets Granite Co. Inc.	Montpelier	01
	Garand, S.L. & Co.	Montpelier	01
	Houle Bros. Granite Co. Inc.	Barre City	01
	Houle-Giudici Granite Co.	Barre City	01
	LaCross Memorials Inc.	Barre City	01
	Nativi & Son Inc.	Barre City	01
	Rock of Ages Corporation	Barre City	04
	Rouleau Granite Company Inc.	Barre City	03
	South Barre Granite Company Inc.	Barre City	01
	Stanley Granite Company Inc.	Rumford	N/A
Massachusetts	W.C. Canniff & Sons Inc.	Boston	01
	W.C. Cannif & Sons Inc.	Quincy	01
Rhode Island	Bonner Monument Co.	Westerly	01
	Pocasset Monumental Works Inc.	Providence	01

TABLE 5 (continued)

State/Province	Company	Location	Size
Connecticut	Bottinelli & Son Granite Co.	New London	01
	Bristol Memorial Works Inc.	Bristol	01
New York	Weilzner Brothers & Paper	New York	01
Pennsylvania	Logue & Son Memorials	Sligo	N/A
	Pennsylvania Monument Co.	Hazleton	01

N/A - not available

Size Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

TABLE 6

MAJOR PRODUCERS OF DIMENSION STONE
WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(DS 10, DS 11, DS 12)

Province/State	Company	Location	Type of Operation
New Brunswick	Dupuis Cut Stone Ltd.	Shediac	Plant
	Nelson Monuments Ltd.	Sussex	Quarries and plant
	Smet Monuments	St. Stephen	Plant
	Smith Cut Stone & Quarries Limited	Shediac	Quarries and plant
Newfoundland	Island Tile & Slate Limited	Trinity Bay	Quarry
Nova Scotia	Construction Aggregates Ltd.	Antigonish	Quarry
Quebec	Carriere Granite Du Nord Enr.	Saguenay	
	Carriere Granitem Inc.	Temiscamique	
	Carriere Moreau Enr.	Lac St-Jean	
	Les Carriers St-Marc (1983) Ltee	Saint-Marc-Des-Carriers	Quarries and plant
	Colombia Granite Inc.	Lac St-Jean, Saguenay	
	Dumas & Voyer Ltee	Riviere-A-Pierre	Quarries and plant
	Elie Grenier Enr.	St-Maurice	

TABLE 6 (continued)

Province/State	Company	Location	Type of Operation
Quebec (continued)	Granicorp Inc.	St-Augustin	Quarries
	Granilac Inc.	Lac St-Jean	Quarries
	Granit Adru Inc.	Stanstead	
	Granit Rose de Guenette Ltee	Labelle	
	Granit St-Gerard (1983) Ltee	St-Gerard	
	Granite Buissiere Inc.	St-Sebastien	Quarries and plant
	Granite Quarriers (CGI) Inc.	Beebe	Quarries
	Granite Nord Americain (NAG) Inc.	Maskinonge	
	Granitremblay Inc.	Saint-Ludger, Delisle, Lac-Saint-Jean	Quarries and plant
	Les Granits Montval (div. of Granitcon Group Inc.)	Laval	Quarries andplants
	A. LaCroix & Fils Granite Ltee	Saint-Sebastien	Quarries and plant
	Roc D'Argent Ltee	Stratford	Quarry

TABLE 6 (continued)

Province/State	Company	Location	Type of Operation
Quebec (continued)	Rock of Ages Du Canada Ltee	Stanstead, Labelle	
	Rocsolide Inc.	Maskinonge	
	Societe Miniere (Polycor Inc.)	Quebec	Quarries
Ontario	Adair Marble, Quarries Division	Wiarton	Quarry/plant
	Amlan Landscaping	Wiarton	Quarry
	Deforest Bros. Quarry Ltd.	Caledon Twp.	Quarry
	Ebel Quarries Ltd.	Amabel Twp.	Quarry
	Flamboro Quarries Limited	Flamborough Twp.	Quarry/plant
	Granite Quarriers (GQI) Inc.	Vermilion Bay	Quarry
	Granomar Quarries Ltd.	Lansdowne Twp.	Quarry
	Hercules Stone Ltd.	Manitoulin Island	Quarry
	Hilltop Stone & Supply Inc.	Halton Hills	Quarry
	Hughes W., Quarry	Pittsburgh Twp.	Quarry

TABLE 6 (continued)

Province/State	Company	Location	Type of Operation
Ontario (continued)	Jackson, Wesley	Lansdowne Twp.	Quarry
	Karnuk Marble Industries Inc.	Cornwall	Plant
	McCartney C.E., Flagstone Quarry Ltd.	Kepple Twp.	Quarry
	Nelson Granite Ltd., (Nelson Monuments Ltd.)	Vermilion Bay,	Quarries/plant
	Owen Sound Ledgerock Limited	Keppel Twp., Amabel Twp.	Quarries/plant
	Payne, Eldred W.	Drummer Twp.	Quarry
	Rama Stone Quarries Ltd.	Rama Twp.	Quarry
	Rice & McHarg Quarries Ltd.	Esquesing Twp.	Quarries
	Rideauview Contractors Ltd.	Storrington Twp.	Quarry
	Rock of Ages Canada Ltd.	Storrington Twp.	Quarry
	Root River Sandstone Quarry	Sault Ste. Marie	Quarry
	Sperian, Karson S.	Rama Twp.	Quarry
	Steep Rock Resources Inc.	Perth	Quarry

TABLE 6 (continued)

Province/State	Company	Location	Type of Operation
Ontario (continued)	Stoklosar Marble Quarries Ltd.	Madoc Twp. Huntingdon Twp. Marmora Twp., Lake Twp.	Quarries
	Windover N. Quarries	Harvey Twp.	Quarries
Maine	Maine-New Hampshire Granite Corp.	Washington Co.	Quarry
	New England Stone Industries Inc.	Crotch Island	Quarry
New Hampshire	Kiltedge Granite Corp.	Hillsborough Co.	Quarry
	Maine-New Hampshire Granite Corp.	Hillsborough Co.	Quarry
	J. Swenson Granite Inc.	Merrimack Co.	Quarry
Vermont	OMYA Inc. Windsor Co.	Rutland Co. &	Quarry and plant
	Rock of Ages Corp. (Sub. of John Swenson Granite Co. Inc.)	Washington Co. & Windsor Co.	Quarries
	John Swenson Granite Co. Inc.	Washington Co.	Quarry
Massachusetts	H.E. Fletcher Co.	Middlesex Co.	Quarry
	Williams Stone Co. Inc.	Berkshire	Quarry

TABLE 6 (continued)

Province/State	Company	Location	Type of Operation
Connecticut	Box Mountain Quarries Inc.	Tolland Co.	Quarry
	Castellucci & Sons Inc.	New Haven Co.	Quarry
	Wayne C. Williams General Construction Inc.	Tolland Co.	Quarry
New York	Finger Lakes Stone Co. Inc.	Tompkins Co.	Quarry
	Heldeberg Bluestone & Marble Co.	Albany Co. & Delaware Co.	Quarries
	Hilltop Slate Co.	Washington Co.	Quarry
	Johnson & Rhodes Bluestone Co.	Delaware Co.	Quarry
	Lake Placid Granite Co.	Essex Co.	Quarry
Pennsylvania	A. Dally & Sons Inc.	Northampton Co.	Quarries and mills
	Delaware Quarries	Bucks Co.	Quarry
	Pennsylvania Granite Corp.	Chester Co.	Quarry

Stone Source	$/Cubic Metre
New Brunswick	175 - 350
Quebec/Ontario	350 - 700
United States	530 - 880
Offshore (South Africa, India, etc.)	1400 - 2100

For Canada overall, prices for monumental and ornamental stone were $112 per tonne in 1985.

For the United States, 1985 prices were as shown in Table 7.

Substitutes. Bronze markers are often used instead of tombstones in the United States. For large memorials such as cenotaphs, bronze or concrete is used as well as stone.

The increasing use of cremation could eventually lead to a reduction in the market for grave markers.

3.2 Building Stone

Description. Perhaps as a reaction against the steel, glass and concrete structures of the 1950-1975 period, architects are using larger quantities of building stone in buildings and landscaping.

This trend aided the new technological advances which have produced thinner slabs and better anchors. The advances have reduced cost, improved handling, and increased the range of applications.

Another trend which is increasing stone use is the restoration of old buildings, many of which have stone architectural elements.

Companies and locations. See Table 5.

Sources and suppliers. See Table 6.

Specifications. There are a number of standard specifications which apply to building stone. Presented in Table 8 are a number of specifications from the American Society for Testing and Materials (ASTM).

In terms of stone selection by architects, the following criteria are often used (DS 4):

- chemical and physical composition, production tolerances, shape, dimensions, weight;
- anchor design, pullout strength, durability;
- general appearance: evenness of colour, grain and texture, surface smoothness and flatness;
- availability of different finishes;
- thermal properties (expansion, conductivity);
- structural serviceability;
- fire safety;
- acoustic properties;
- durability (wear, corrosion);
- handling and delivery service.

Dimension Stone

Stone veneers for building cladding come in granite, marble and sandstone. Common sizes are 1.0 x 0.5 x 0.035 metres and 2.0 x 1.0 x 0.064 metres; the stone tends to bow if its ratio of surface area to thickness is any higher (DS 4).

For restoration projects larger stone blocks are often required to replace columns, capitals, cornerstones, keystones, etc. Matching the new stone to the old is a key specification and sometimes for large projects old quarries are reopened. (DS 4)

Prices. In 1985, building stone prices for monumental and ornamental stone in Canada were $112 per tonne and for flagstones, curbstone, paving blocks, etc., $53.

Prices in the Atlantic Provinces were in the range presented in Section 3.1 ($54-$640 per square metre).

In Ontario the following prices in 1986 were recorded (DS 4):

Use	Price per Cubic Metre
granite veneer (installed)	$ 270 - $ 540 (per square metre)
marble or granite pavers (installed)	85 - 215 (per square metre)
finished limestone	700 (10 cm thick)
rough limestone block (from Indiana)	390
finished, shaped limestone	3200 - 7000

For the United States, building stone prices in 1985 were as presented in Table 7.

Substitutes. Building stone competes with a wide range of high quality products for flooring (terrazzo, tile, carpet, wood, concrete), exterior cladding (glass, concrete, stucco, brick,

TABLE 7

VALUE OF DIMENSION STONE ($CDN/TONNE)
SOLD OR USED BY PRODUCERS IN THE UNITED STATES, 1985
(DS 2)

Use	Stone Type				
	Granite	Limestone	Marble	Sandstone	Slate
Rough stone					
Monumental	150	--	--	--	-
Dressed stone					
Ashlars and partially squared pieces	365	375	--	125	--
Slabs and blocks for building and construction	540	370	1040	315	--
Monumental	610	140	--	--	--
Curbing	270	50	--	--	--
Flagging	--	--	--	105	170
Roofing slate	--	--	--	--	740
Structural and sanitary	--	--	--	--	740
Flooring slate	--	--	--	--	550
Other	200	60	1390	65	--

metal) and interior finishes (wallboard, mirrors, wood, fabric). The demand for any of these competing materials depends upon price, availability, and architectural fashion.

Of greater concern to stone producers, however, are "artificial stone" products. They are intended to replace natural stone by meeting or exceeding stone properties at a lower price. Marble and granite look-alikes are made with a combination of resins, rock chips and silica aggregate; artificial slate roofing is made from ground slate, glass fibres, and resin binders. (DS 2)

3.3 Curbing

Description. Granite curbing has become common in many downtown areas of North America, especially in downtown revitalization or renewal projects.

The growth in granite curbing has been driven by its superior appearance and performance with respect to concrete and asphalt. Studies have shown it to have a better life-cycle cost as well, although it is more expensive initially.

Companies and locations. See Table 5.

Sources and suppliers. See Table 6.

Specifications. Referring to Table 8 specifications C131-55, C218-48T, C241-51 and C615-80 would apply to granite curbing.

Prices. See Sections 3.1 and 3.2.

Substitutes. Concrete and asphalt are also used for curbing.

TABLE 8

SPECIFICATIONS OF THE AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) WHICH PERTAIN TO BUILDING STONE (DS 4)

C97-83	Absorption and bulk specific gravity
C99-52	Modulus of rupture
C119-83C	Standard definitions of terms
C120-52	Flexure testing of slate
C121-48	Water absorption of slate
C131-55	Abrasion resistance by Los Angeles Test
C170-50	Compressive strength
C217-58	Weather resistance of natural slate
C218-48T	Combined effort of temperature cycles and wash salt solutions on natural building stones
C241-51	Abrasion resistance of stone subjected to foot traffic
C406-84	Roofing slate
C503-79	Exterior marble
C543-81	Slate blackboards
C568-79	Dimension limestone
C615-80	Granite building stone
C616-80	Building sandstone
C629-8	Structural slate

4.0 BIBLIOGRAPHY (DIMENSION STONE)

DS 1 Vagt, O., "Stone." Publication from Canadian Minerals Yearbook 1987, Ottawa, Ont.: Canadian Government Publishing Centre, 1988.

DS 2 Taylor, Harold A. Jr. "Dimension Stone." Preprint, from 1986 Bureau of Mines Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1987.

DS 3 Robinson, Thomsa A. "An Analysis of the Monument Market - Present Conditions and Future Trends." Dimension Stone, June 1988; pp. 30-32.

DS 4 DPA Group Inc. and Jacques Whitford & Associates Ltd. "Market Analysis for New Brunswick, Nova Scotia and Newfoundland - Dimension Stone", Open File Report 87-10, 1987.

DS 5 McGee, Arlee. "St. George: A Granite Town's Legacy," Atlantic Advocate, April 1986, pp. 29-31.

DS 6 Wright, W.J. "Preliminary Report of the Granite Industry of St. George, Charlotte Co., N.B.," New Brunswick Department of Lands and Mines, Mining Section, 1934, pp. 1-30.

DS 7 Parks, W.A. "Report on the Buildings and Ornamental Stones of Canada, Vol. II, Maritime Provinces," Canada, Department of Mines, No. 203, 1914.

DS 8 Carr, G.F. "Granites of New Brunswick - The Granite Industry of Canada," Mines Branch, Ottawa, No. 846, 1955, pp. 1-30.

DS 9 Adolph, Carolyn. "Granite on the Cutting Edge - Canada Adopts Italian Methods of Preparation," source unknown.

DS 10 Active Canadian Granite Producers. Ontario: Ministry of Northern Development and Mines.

DS 11 Building Stone Quarries in Ontario - Directory, May 1988. Ontario: Mineral Development and Lands Branch, Mines and Minerals Division, 1988.

DS 12 U.S. Department of the Interior. Bureau of Mines Minerals Yearbook, 1985. 3 vols. Washington, D.C.: Government Printing Office, 1987.

GYPSUM

G Y P S U M

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	114
2.0	PRODUCTION STATUS IN NEW BRUNSWICK	115
3.0	CONSUMPTION	121
3.1	Prefabricated Products (Wallboard)	121
3.2	Building and Industrial Plasters	136
3.3	Portland Cement	140
3.4	Agricultural Use	141
3.5	Consumption Estimates	142
4.0	BIBLIOGRAPHY	145

G Y P S U M

LIST OF TABLES

		Page
TABLE 1	NEW BRUNSWICK GYPSUM PRODUCTION, 1946-1987	119
TABLE 2	CONSUMPTION OF GYPSUM IN THE UNITED STATES, 1985 AND 1986	122
TABLE 3	GYPSUM WALLBOARD PRODUCTION IN CANADA, 1984-1987	125
TABLE 4	UNITED STATES PREFABRICATED PRODUCTS SOLD OR USED, 1984-1986	126
TABLE 5	GYPSUM MINING AND MANUFACTURING WITHIN 800 KILOMETRES OF NEW BRUNSWICK	128
TABLE 6(A)	VARIATION IN RETAIL PRICES FOR GYPSUM WALLBOARD IN FOUR MARITIME CITIES, JUNE 1988 ..	134
TABLE 6(B)	VARIATION IN PRICES FOR GYPSUM WALLBOARD IN SIX EASTERN NORTH AMERICAN CITIES, 1982-1987 ..	135
TABLE 7	VARIATION IN PRICES FOR PLASTER FOR SIX EASTERN NORTH AMERICAN CITIES, 1986-1987	139

LIST OF FIGURES

		Page
FIGURE 1	NEW BRUNSWICK GYPSUM PRODUCTION	120
FIGURE 2	CONSUMPTION OF GYPSUM IN THE UNITED STATES, 1988 AND 1986 (INCLUDING IMPORTED GYPSUM AND IMPORTED GYPSUM PRODUCTS)	123

GYPSUM

1.0 INTRODUCTION

Definition. Gypsum is a hydrous calcium sulphate with the chemical formula ($CaSO_4.2H_2O$). When calcined or heated to temperatures between 120° and 205°C, gypsum loses three-quarters of its water of hydration. Its new chemical formula becomes $CaSO_4.\frac{1}{2}H_2O$. Calcined gypsum or hemihydrate of calcium sulphate is commonly known as plaster of paris. When gypsum loses all its water of hydration (temperatures of 700°C), it becomes anhydrous calcium sulphate, or anhydrate ($CaSO_4$).

Special properties.

1) Gypsum retards the setting time of cement.

2) Gypsum is used as a soil conditioner and fertilizer providing tilth, calcium and sulphur.

3) Plaster of paris, when mixed with water can be spread, molded, or shaped. When dried, the material sets to a hard plaster (gypsum).

4) Gypsum products have good fire-retardant properties because the water of hydration is released at relatively low temperatures.

5) Gypsum powder is white, soft, and nonreactive, which makes it useful as a filler in paint and paper.

6) All gypsum products can be used as sources of elemental sulphur for the chemical process industry.

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

Gypsum has had a small but significant role in the mineral economy of New Brunswick for over a century. In the early 1800s farmers quarried the rock to use as a soil amendment known as "land plaster". Until recently, there has been almost continuous production of gypsum in the Hillsborough, Albert County area since 1847. Deposits at Intervale, Sussex, Upham and Plaster Rock have also been past producers.

Exports of gypsum from Hillsborough in 1847 were shipped by coastal vessels to "plaster" mills in Lubec, Maine and other United States destinations. It became known as a source of superior quality plaster of paris. In 1854 the operation was sold and enlarged and a calcining mill was constructed by the Albert Manufacturing Company. This enabled shipments of manufactured product which continued until the withdrawal of reciprocal trade relations between Canada and the U.S. led to a decline. The high quality of the material allowed retention of a smaller market share and finer grades of calcined plaster, used for casting and dental purposes, were manufactured in New York from rock plaster supplied from Hillsborough or Windsor, N.S. In 1876, the Intercolonial Railway (now CNR) was constructed and it became possible to capture a share of the central Canada market. However, operations near Montreal and in Ontario, as well as the United States provided competition. The institution of a Canadian protective tariff combined with the higher quality of the Hillsborough material led to the rapid capture of the major share of the Canadian market. In 1877 total sales in Canada were 8000 barrels; by 1897 Hillsborough sold about 38 000 barrels on the Canadian market. In the same time period shipments of crude gypsum to the U.S. increased from 5000 tons to 59 000 tons. The imposition of import duties on

crude products led to a decline in the market. However, total loss of the market to western U.S. producers was avoided due to the lobbying efforts of the eastern U.S. manufacturers, who were concerned about the capital invested in their plants. Additional pressure was exerted by the owners of coastal vessels who transported coal from New York north to New England ports and used the gypsum as a "backhaul" commodity for the return trip.

The Hillsborough plaster mill was destroyed by fire in 1911 but was rebuilt and enlarged to a capacity of 1000 barrels of plaster per day in 1912. Just prior to 1930, two large reinforced concrete silos equipped with ship loading conveyors were constructed at the Hillsborough docksite on the Petitcodiac River. These silos, which are still standing, are believed to be the first structures erected in eastern Canada using the continuously poured slip ring method of construction.

In 1930, the first wallboard plant in eastern Canada was constructed at the existing Hillsborough manufacturing facilities when the Canadian Gypsum Company acquired the plant from the Albert Manufacturing Company. The calcining capacity was increased with some of the equipment transferred from the old Iona mill. Shipments of crude gypsum ceased shortly after the Second World War.

Underground mines were common in the Hillsborough area until 1958. The room and pillar method was used with some "rooms" reaching 14 m in height. One four level mine was closed in 1930 for safety reasons. Surface quarries were also used and eventually became the only method employed.

In addition to the main operations at Hillsborough, another producer was located about 10 km to the southwest at Demoiselle Creek, near Albert Mines (also called the Albert Mines Deposit). The area was first worked by the Hillsborough Plaster Company.

In 1892, 600 tons were shipped to New York for the manufacture of "cold water paint". In later years the quarry and mine were operated by the Wentworth Gypsum Company. The Demoiselle Creek quarry eventually became part of the Canadian Gypsum Company operation and was apparently operated intermittently.

A deposit at Intervale, about 5 km north of Petitcodiac has also operated periodically. Initial quarrying was undertaken in 1880. The Albert Manufacturing Company produced about 1300 tons per year from 1932 to 1935. In 1950, the property was acquired by Canada Cement Company Limited. The quarry is operated on an as-required basis for use as a retarding agent for portland cement manufacture at their plant in Havelock, N.B.

Deposits in the Tobique Valley area of northwestern New Brunswick are regarded as poor quality for plaster but was in high demand as a soil amendment ("land plaster") in the 1890s. One of the reasons for construction of a railway from Perth to Plaster Rock was for transport of the commodity. The Tobique Valley Gypsum Mining and Manufacturing Company was incorporated in 1893 and erected crushing and grinding equipment on the rail line. Some production was achieved with good results reported from use as "land plaster" but transportation difficulties were encountered with railway facilities and rates. An ownership change occurred in 1897 and no further production has been reported.

Peak production of gypsum from Hillsborough (in New Brunswick) was reported in 1906 at a rate of about 119 000 tonnes per year. Production rates of 75 000 to 100 000 tonnes per year were common in the 1950s and 1960s. About 40 000 to 50 000 tonnes per year were produced during the 1970s. This production was used for the manufacture of gypsum wallboard at the Canadian Gypsum Company operation. Production ceased with the closure of this facility in 1980. The closure was a function of a downturn

in the construction industry, high transportation costs, and outdated equipment. Table 1 and Figure 1 summarize production statistics for the past forty years.

Since 1986, Eastern Gypsum Ltd. has been considering the establishment of a wallboard manufacturing facility at MacAdam, N.B. to serve northeastern U.S. markets. They have evaluated gypsum deposits in the Albert County area and near Sussex as potential sources of supply. This proposed development is the most topical subject with regard to the future of gypsum production in the Province.

By-product gypsum is also available in the Province. By-product gypsum is a chemical product of manufacturing processes such as phosphoric acid production. Brunswick Mining and Smelting Corporation Limited (Fertilizer Division) produces substantial quantities of phosphogypsum as a waste product of fertilizer production (see process description in Phosphate Rock section.)

Sludge produced by scrubbers in flue gas desulphurization is also a by-product gypsum. Thermal power plants and the Chatham coal/oil shale fluidized bed combustor are potential small scale sources in the Province.

TABLE 1

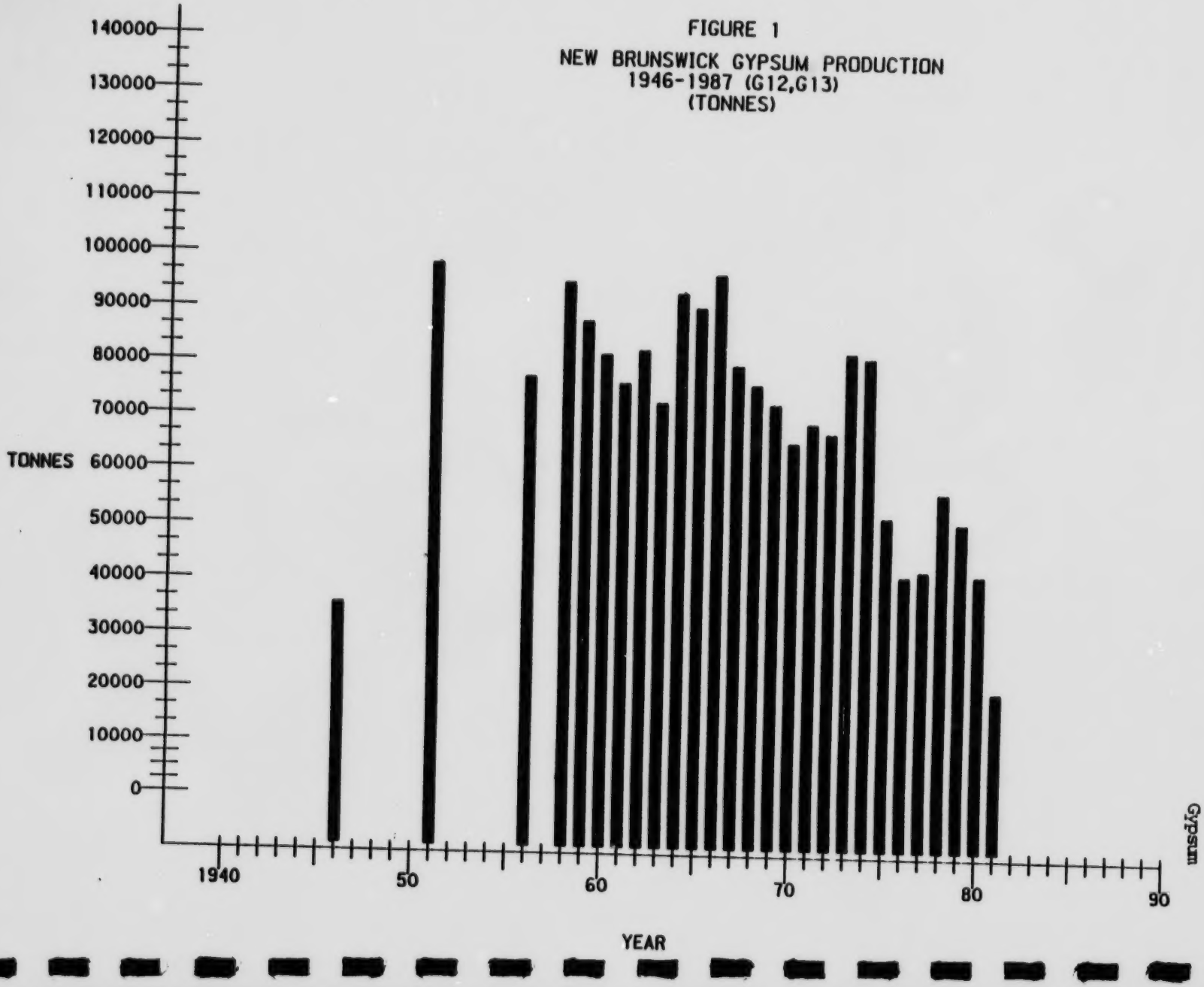
NEW BRUNSWICK GYPSUM PRODUCTION
(G12, G13)
1946-1987

Year	Tonnes (Thousands)	Current Dollars (Thousands)	Constant 1985 Dollars (Thousands)
1946	35.2	$551	$4 021
1947	NA	NA	
1948	NA	NA	
1949	NA	NA	
1950	NA	NA	
1951	99.3	328	1 632
1952	NA	NA	
1953	NA	NA	
1954	NA	NA	
1955	NA	NA	
1956	78.1	224	1 075
1957	NA	NA	
1958	96.2	171	775
1959	88.9	133	595
1960	82.6	267	1 179
1961	77.1	137	601
1962	83.5	162	702
1963	73.5	139	591
1964	94.4	215	680
1965	91.7	211	860
1966	98.0	413	1 627
1967	80.8	182	691
1968	77.1	173	631
1969	73.5	135	471
1970	66.2	157	531
1971	69.9	259	851
1972	68.1	220	690
1973	83.5	266	775
1974	82.6	300	788
1975	52.6	209	495
1976	41.7	177	390
1977	42.7	204	417
1978	57.2	379	711
1979	51.7	424	728
1980	42.0	201	314
1981	20.0	87	121
1982	0.0	0	0
1983	0.0	0	0
1984	0.0	0	0
1985	0.0	0	0
1986	0.0	0	0
1987	0.0	0	0

NA - data not available

FIGURE 1

NEW BRUNSWICK GYPSUM PRODUCTION
1946-1987 (G12,G13)
(TONNES)



3.0 CONSUMPTION

Use and quantities. While gypsum has many applications, most gypsum production is directed to four main uses: prefabricated products (wallboard), plaster, portland cement, and agriculture. Together, these four uses accounted for over 99 percent of consumption in the United States in 1986 (see Table 2 and Figure 2). (G1) In Canada 68 percent of gypsum production was exported in 1986 (80 percent in 1984) almost entirely to the United States. Of the material used in Canada the largest proportion was for wallboard. (G2)

3.1 Prefabricated Products (Wallboard)

Description. The term "prefabricated products" refers to a group of manufactured gypsum products which are mainly used in the building industry. These products include:

a) regular wallboard which is mainly used to finish interior walls in homes and offices. It comes in sheets, usually 4 ft by 8 ft (1.2 m x 2.4 m), available in thicknesses of 1/4", 3/8", 7/16", 1/2", 5/8" and 1" (0.64 cm, 0.95 cm, 1.11 cm, 1.27 cm, 1.59 cm and 2.54 cm).*

b) Type X or fire-resistant wallboard which is used to finish interior spaces requiring high fire resistance such as stairwells and elevator shafts. It comes in sheets like wallboard.

---

*Imperial units are the standard in the North American wallboard industry.

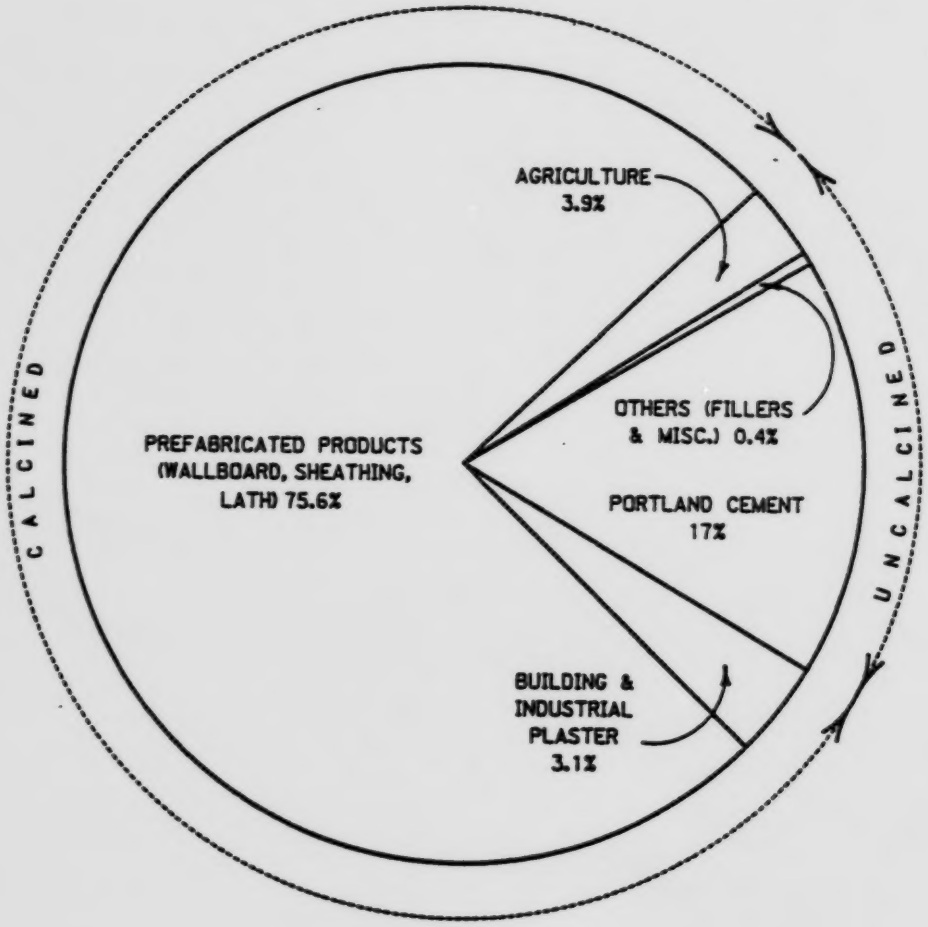
TABLE 2

CONSUMPTION OF GYPSUM IN THE UNITED STATES, 1985 AND 1986
(including imported gypsum and imported gypsum products) (G1)

Use	Consumption, tonnes (M) 1985		1986	
	tonnes (M)	%	tonnes (M)	%
Uncalcined				
- agriculture	1.1	4.9	0.9	3.9
- portland cement	3.9	17.3	3.9	17.0
- others (fillers and miscellaneous)	0.1	0.4	0.1	0.4
Calcined				
- building and industrial plaster	0.7	3.1	0.7	3.1
- prefabricated products (wallboard, lath, sheathing)	16.7	74.2	17.3	75.5
TOTAL	22.5	100.0	22.9	100.0

FIGURE 2

CONSUMPTION OF GYPSUM IN THE UNITED STATES, 1985 & 1986
(INCLUDING IMPORTED GYPSUM & IMPORTED GYPSUM PRODUCTS)
(G1)



c) lath which is used as a base support for plaster.

d) veneer base which is used as a core material for hardwood panels.

e) sheathing which is used for exterior wall panels.

f) predecorated wallboard which is a panel used for office partitions and other uses.

g) others.

Table 3 provides wallboard production and consumption figures for Canada in 1984-1986. (G3)

Table 4 provides figures on wallboard consumption in the United States in the 1981-1986 period. (G1)

The popularity of these "wallboard" products is due to four main advantages:

i) Wallboard is a low-cost product for finishing walls and ceilings;

ii) The installation of wallboard relative to other wall finishes is inexpensive and easy;

iii) Wallboard has good fire resistance; and

iv) Wallboard provides an attractive, versatile finish.

TABLE 3

GYPSUM WALLBOARD PRODUCTION IN CANADA, 1984-1987
(G3, G9, G10, G11)
PRODUCTION (M SQUARE METRES)

Product	1984	1985	1986	1987P
Plain wallboard	237.0	241.0	295.9	339.7
Wallboard overlaid with vinyl	2.8	2.9	3.0	3.4
Sheathing (estimate)	2.8	2.8	**	2.4
Lath	*	*	*	*
Total production	242.6	246.7	298.9	345.5
Exports to United States	54.8	53.0	77.5	71.5
Total Canadian Consumption	187.8	193.7	221.4	274.0

* data not available
**confidential
P preliminary

TABLE 4

UNITED STATES PREFABRICATED PRODUCTS SOLD OR USED, m^2 (M) (1984-1986), G1

Product	1984	1985	1986
Lath			
- 3/8" (0.95 cm)	2.8	2.6	2.2
- 1/2" (1.27 cm)	0.1	0.2	0.1
Regular Wallboard			
- 3/8" (0.95 cm)	44.2	42.2	40.3
- 1/2" (1.27 cm)	975.1	1008.7	1068.3
- 5/8" (1.59 cm)	120.7	129.8	146.7
- 1" (2.54 cm)	5.7	7.4	7.9
- Other	15.1	25.7	21.2
Type X Gypsum Board	375.6	407.8	405.1
Veneer Base	37.9	39.9	42.2
Sheathing	31.4	32.5	31.4
Predecorated Wallboard	11.8	12.5	12.3
5/16" Mobile Home Board	79.4	60.6	53.1
Water/Moisture-Resistant Board	--	44.4	48.5
Other	2.4	0.5	7.9
TOTAL	1702.2	1814.8	1838.7

Sources and suppliers. Wallboard production in North America is controlled by a few large firms. In the United States, the largest firms are United States Gypsum Co. (22 plants, 35 percent of the wallboard output in 1985), National Gypsum Co. (18 plants, 25 percent of output), Georgia-Pacific Co. (9 plants, 13 percent of output), Genstar Gypsum (5 plants)*, and Celotex (4 plants). Together, the five firms accounted for 83 percent of the United States output in 1986. (G1, G4)

The largest firms in Canada are: Domtar Inc. (5 plants), Westroc Industries Limited (5 plants), and Canadian Gypsum Company Limited (2 plants).

The integrated nature of the North American market is apparent by the large number of multinational firms: Canadian Gypsum Company Limited is a subsidiary of United States Gypsum Co.; Domtar Inc. owns Genstar Gypsum in the United States; and Westroc Industries Limited is owned by a British company. In addition, National Gypsum Co. and Georgia-Pacific own quarries in Nova Scotia.

Presented in Table 5 is a list of all the gypsum producers and gypsum and plaster plant facilities within 800 km of the New Brunswick border. Further details are presented in the Consumer's Directory.

All three of the largest American gypsum firms have quarries in Nova Scotia. The importance of Nova Scotia gypsum is apparent from reviewing Table 5: of 12 calcinating plants in the United States and Quebec, all are supplied by Nova Scotia gypsum, except for one in New York State (near Buffalo, has its own quarry) and one in New Jersey (uses Spanish gypsum).

---

*Genstar Gypsum operations were sold to Domtar Inc. in 1986.

TABLE 5

GYPSUM MINING AND MANUFACTURING WITHIN 800 KM OF NEW BRUNSWICK
(G1, G2, G5)

Province	Location	Owner	Facility		Notes
			Mine	Plant	
New Brunswick	Intervale	Lafarge Canada Inc. (formerly Canada Cement Lafarge Ltd.)	quarry		for cement manufacture.
Newfoundland	Flat Bay	Flintkote Holdings Limited	quarry		
	Corner Brook	Atlantic Gypsum Limited		wallboard	75 employees in 1984. Gypsum from Flat Bay. Production capacity: 0.060 M tonnes.
Nova Scotia	McKay Settlement	Domtar Inc.	quarry		by contract.
	Windsor	Domtar Inc.		plaster and "gypcrete"	
	Wentworth and Miller Creek	Fundy Gypsum Company Limited	quarry		gypsum and anhydrite.
	River Denys	Georgia-Pacific Corp.	quarry		new quarry areas developed in 1984.
	Little Narrows	Little Narrows Gypsum Company Limited	quarry		gypsum and anhydrite. New quarry areas developed in 1984.
	Milford	National Gypsum (Canada) Ltd.	quarry		

TABLE 5 (continued)

Province	Location	Owner	Facility		Notes
			Mine	Plant	
Quebec	Montréal	Canadian Gypsum Company (a Division of CGC Inc.)		wallboard	imported gypsum (Nova Scotia). New equipment installed in 1985.
	Joliette	Canadian Gypsum Company (a Division of CGC Inc.)		roof paper, wallboard paper	124 employees in 1984.
	St-Jerome	Canadian Gypsum Company (a Division of CGC Inc.)		wallboard	closed in 1982, open in 1984. Imported gypsum (Nova Scotia). 26 employees in 1984. (not open in 1987)
	Montréal	Domtar Inc.			former plant now used as a distribution terminal. 90 employees in 1984.
	St-Catharine d'Alexandrie	Westroc Industries Ltd.		wallboard	114 employees in 1984.
Ontario	Hagersville	Canadian Gypsum Company (a Division of CGC Inc.)	underground	wallboard	260 employees in 1984.
	Caledonia	Domtar Inc.	underground	wallboard	180 employees in 1984.
	Drumbo	Westroc Industries Ltd.	underground		annual output: 0.110 M tonnes.
	Clarkson (Mississauga)	Westroc Industries Ltd.		wallboard	250 employees in 1984.

TABLE 5 (continued)

State	Location	Owner	Facility		Notes
			Mine	Plant	
New Hampshire	Portsmouth, Rockingham County	National Gypsum Co.		wallboard	imports gypsum from Nova Scotia through Portsmouth. Under 0.25 M tons consumed in 1983. 1 of 18 plants owned by National Gypsum in the United States.
Massachusetts	Boston, Suffolk County	United States Gypsum Co.		wallboard	imports gypsum from Nova Scotia. Under 0.25 M tons consumed in 1983. Sold throughout New England.
New York	Oakfield, Genesee County	United States Gypsum Co.	underground		beds are 3-4 feet thick. Full-time operations, 50 to 99 employees. Under 0.25 M tons mined in 1983.
	Oakfield, Genesee County	United States Gypsum Co.		calcined	uses mined and Canadian (Nova Scotia?) material. Under 0.25 M tons consumed in 1983.
	Greene	E. Conrad	pit		intermittent operation; 1 to 4 employees.
	Stoney Point, Rockland County	United States Gypsum Co.		calcined	sixth largest plant in United States (1986); problems with dust controls. Uses Canadian (Nova Scotia) material. Over 0.25 M tons consumed in 1983.

TABLE 5 (continued)

State	Location	Owner	Facility		Notes
			Mine	Plant	
New York (continued)	E. Greenbush, Rensselaer County	National Gypsum Co.		wallboard, plaster	out-of-state gypsum (likely Nova Scotia). Under 0.25 M tons consumed in 1983.
	Buchanan, Westchester County	Georgia-Pacific Corp.		wallboard, plaster	out-of-state gypsum (likely Nova Scotia). Under 0.25 M tons consumed in 1983.
	Clarence Center, Erie County	National Gypsum Co.			reclamation project for waste gypsum mounds, plant closed in 1982.
New Jersey	Burlington County	National Gypsum Co.		wallboard, plaster	Nova Scotia gypsum. Under 0.25 M tons consumed in 1983.
	Port Newark	Atlantic Gypsum Co.		wallboard	$34 M (U.S.) plant set to commence product in early 1988 using gypsum imported from Spain.
	Camden County	Genstar Building Materials Co.		wallboard, plaster	Nova Scotia gypsum, plant closed in 1982, opened in 1983. Under 0.25 M tons consumed in 1983. Genstar plants were purchased by Domtar Inc. in 1985.

TABLE 5 (continued)

State	Location	Owner	Facility		Notes
			Mine	Plant	
Pennsylvania	Philadelphia	United States Gypsum Co.		wallboard, lath	plant closed during 1981 recession, reopened in 1983. Nova Scotia gypsum. Under 0.25 M tons consumed in 1983.

SUMMARY STATEMENT FOR TABLE 5

	Quantity	Type of Facility
Canada:	7	Quarry
	3	Underground Mine
	9	Plants
United States:		
	1	Pit
	1	Underground Mine
	10	Plants

Specifications.

Gypsum for wallboard production should be at least 70 percent pure. Impurities of concern are anhydrite, clay, limestone, dolomite, shale, and chlorides which can affect plaster properties (colour, set lime consistency) and are undesirable. Raw gypsum for processing should be in the form of 5-10 centimetre lumps. A minimum size of 15-20 centimetres is permitted while fines under 0.4 centimetres are undesirable. (G5, G7)

Prices. Prices for 1/2" (1.27 cm) and 3/8" (0.95 cm) gypsum wallboard for several cities within 800 km of New Brunswick are presented in Tables 6a and 6b, respectively. Gypsum wallboard is often treated as a loss-leader or low markup product by building supply stores as store management use wallboard to encourage repeat business. Even so, there was a 28 percent difference in wallboard prices between stores in Halifax and Moncton in spring, 1988. Over five years (July 1982 to April 1987) prices increased by 54 percent to 118 percent, equivalent to average annual increases of 9 percent to 17 percent--well above the inflation rate. However, pricing in the last year has been quite variable, ranging from 12 percent decrease (Boston) to 34 percent increase (Montréal).

Substitutes. There are many ceiling and wall surface materials which are used in place of gypsum wallboard. Veneer paneling, plywood, particleboard, cloth partitions, hung ceilings, structural masonry walls, plaster, and other materials have been used with success. However, none have greatly affected gypsum wallboard consumption in the home building market, and only hung ceilings and cloth partitions have affected consumption in the office market. Wallboard's low cost, ease of installation, fire resistance, and durability and attractiveness as a finish material are reasons for its continued dominance in the construction market.

TABLE 6(A)

VARIATION IN RETAIL PRICES FOR GYPSUM WALLBOARD (0.50")
IN FOUR MARITIME CITIES, JUNE 1988
(PER 3200 FT^2; 100 SHEETS @ 4'X8')
(FROM TELEPHONE SURVEY)

City	Source #1	Source #2
Fredericton	$779.00	$799.00
Moncton	899.00	925.00
Saint John	779.00	779.00
Halifax	779.00	720.00*

*Price as of June 13, 1988; prior to this, the price was $755.00.

TABLE 6(B)

VARIATION IN PRICES FOR GYPSUM WALLBOARD (0.375")
IN SIX EASTERN NORTH AMERICAN CITIES 1982-1987
(PER 1000 ft^2 (93 m^2))
(Cd)

City	1982	1983	1984				1985				1986				1987		Number of Price Changes in Period
	July	January	January	April	June	November	January	April	June	November	January	April	July	November	January	April	
Montreal	$168.55	$168.55	$187.70	$187.70	$187.70	$194.25	$194.25	$194.25	$194.25	$204.65	$204.00	$204.00	$260.00	$260.00	$273.50	$273.50	6
Toronto	170.40	160.00	160.00	174.00	192.00	192.00	192.00	199.00	209.50	220.00	$233.20	$230.00	$242.00	$242.00	262.00	262.00	10
Boston	155.00	160.00	209.00	230.00	230.00	210.00	210.00	247.50	246.50	262.50	$262.50	$294.45	$280.00	$280.00	260.00	260.00	9
New York	110.00	110.00	110.00	110.00	110.00	232.00	232.00	232.00	232.00	240.00	$240.00	$240.00	$240.00	$240.00	240.00	240.00	2
Philadelphia	123.00	128.00	195.00	205.00	210.00	210.00	210.00	210.00	210.00	225.00	$225.00	$225.00	$225.00	$225.00	225.00	225.00	5
Baltimore	112.00	112.00	173.00	173.00	173.00	193.00	193.00	193.00	230.00	230.00	$230.00	$230.00	$208.00	$208.00	208.00	208.00	4

3.2 Building and Industrial Plasters

Description. Plasters can be calcined, raw, or anhydrous, depending upon application. Plasters are used for a variety of industrial and building purposes. Key features of plasters are white colour, controlled sitting time (can be short or long), closely controlled shrinkage/expansion characteristics, cementing properties, soundproofing, density variation (can be low or high), dessiccant properties (in anhydrous form, as a bonder), low abrasion, fire retardancy, low cost and ease of handling.

Among plaster's many uses (G1, G2) are:

i) wall plaster for homes and buildings. This use has been largely displaced by gypsum wallboard. This is a calcined plaster which is mixed with retarders, accelerators or other chemicals to affect its properties.

ii) molding plaster. A calcined plaster used for making molds for ceramics, pottery, metal casting and decorative objects.

iii) casting plaster. A calcined plaster used for medical and dental purposes. Often, casting plasters have accelerators to hasten setting.

iv) well-drilling plaster. A low-consistency calcined plaster used to seal porous rocks during well drilling, especially for gas and oil.

v) Keenes cement. Used as a wall plaster with extra density, strength and hardness.

Sources and suppliers. Most plaster is in calcined or anhydrite form so suppliers must have calcining operation. For this reason, most plaster comes from the large wallboard manufacturers. Domtar, for example, has plaster and "gypcrete" plants in Windsor, NS and Calgary, AB.

Consumers. There is a large quantity of material consumed, but there are many consumers, few of which would use more than a few hundred tons of plaster each year (building contractors, plasterers, foundries).

Specifications. The specifications vary with the intended use and can cover such characteristics as:

a) whiteness
b) sitting time (from 5 miutes to 6 hours)
c) expansion/shrinkage
d) density
e) strength
f) water absorbancy
g) purity
h) hardness.

The specifications are usually set by the consumer and not an independent agency such as ASTM or CSA.

Prices. Plaster prices can vary from half the price of regular calcined gypsum ($182.00/tonne (Cdn) in 1986) to over 150 percent of that value, depending on the order quantity and processing required to meet specifications. In 1986, United States prices (in $ Cdn) were:

Building plaster	
- regular base coat	$164.00/tonne
- poured gypsum cement and concrete	102.00
- veneer plaster	225.00
- gauging plaster and Keene's cement	187.00
- other	256.00
Industrial plaster	167.00

Table 7 presents prices for two plaster products (neat and gauging) for 1986 and 1987*.

Substitutes. There are common substitutes for many plaster uses:

a) wall plaster. It has been largely replaced by gypsum wallboard, wood panels, exposed concrete blocks and other finishes.

b) casting plaster. Plastics are available which fulfill some of the needs met by casting plaster.

c) molding plaster. Silica sand and other materials can be used in place of gypsum in metal casting.

Lime mortars, cement, and concrete can be substituted for some plaster uses.

---

*gauging plaster is the rough coat applied to lath, neat plaster is the finish coat applied on top of gauge plaster.

TABLE 7

VARIATION IN PRICE FOR PLASTER FOR SIX EASTERN NORTH AMERICAN CITIES (CDN $/TON)
(GB)

City	1986								1987			
	January		April		June		November		January		April	
	Neat	Gauging	Neat	Gauging	Neat	Gauging	Neat	Gauging	Neat	Gauging	Neat	Gauging
Montreal	$238.00	$363.00	$238.00	$363.00	$238.00	$363.00	$278.00	$390.00	$260.00	$445.00	$260.00	$445.00
Toronto	-	318.00	-	327.27	-	327.27	-	376.36	363.60	430.86	363.60	430.86
Boston	176.00	295.00	176.00	295.00	176.00	295.00	176.00	295.00	176.00	295.00	176.00	295.00
New York	12.70[a]	15.70[b]	12.70[a]	15.70[b]	12.70[a]	15.70[b]	12.70[a]	15.70[b]	12.70[a]	15.70[b]	12.70[a]	15.70[b]
Philadelphia	204.00	268.00	204.00	268.00	204.00	268.00	204.00	268.00	204.00	268.00	204.00	268.00
Baltimore	196.88	237.00	198.00	241.00	198.00	241.00	198.00	241.00	198.00	241.00	-	-

[a] - per 80-lb bag
[b] - per 100-lb bag

3.3 Portland Cement

Description. Uncalcined or raw gypsum acts as a set inhibitor for portland cement. Cement producers grind up to 6 percent (by weight) gypsum with cement clinker to get intimate mixing of the two mineral products. Gypsum also controls both the rate at which the cement paste develops strength and the amount of shrinkage of concrete during setting. Some cement plants use a mixture of cement and anhydrite.

Sources and suppliers. Ma[illegible] cement plants obtain their gypsum from their own quarries (example: Lafarge Canada Inc. from Intervale), while others purchase gypsum from gypsum producers (example: cement plants in Ontario and Quebec use gypsum mined in Nova Scotia).

Consumers. The Directory of Consumers provides a list of cement producers within 800 km of New Brunswick as well as "Cement and Cement Products".

Specifications. The use of gypsum and anhydrite in cement manufacture is governed by ASTM Standards (see "Cement and Cement Products"). Research has shown that the quantity of gypsum required is dependent upon the sulfate content of the gypsum, the type of cement desired, and the mixture of raw materials used in the cement clinker. With increased research, cement producers are requiring that gypsum suppliers meet more stringent supply specifications (sulfate content, uniformity).

Prices. Gypsum used for cement requires little processing other than blending for gypsum/anhydrite mixtures (used by only some plants). Thus the price for cement gypsum ($12.50 (Cdn) per tonne in the United States in 1986) is that for uncalcined gypsum plus transportation costs.

Substitutes. There is no practical substitute for gypsum in cement production.

3.4 Agricultural Use

Description. "Land plaster" is finely ground gypsum or anhydrite which is applied directly to the land. It fulfills several purposes as an agricultural chemical including:

1) improving the structure or tilth of soil (breaking up heavy clays, increasing porosity, aiding drainage);

2) supplying neutral, soluble calcium as a nutrient for crops like peanuts;

3) supplying sulfate sulfur as an available nutrient quickly;

4) supplying calcium to replace sodium in alkali soils and saline irrigation water;

5) improving the sulfur to nitrogen relationship in the soil, thus freeing nitrogen for plant use;

6) clarifying muddy farm ponds;

7) stimulating soil and silage organisms;

8) supplementing animal feeds (cattle, sheep) by supplying sulfur and increasing nitrogen availability.

Sources and suppliers. As a small volume, relatively low-value use, land plaster is generally either supplied locally or as a small part of a larger gypsum shipment. An example of the former case would be a small quarry supplying local farmers; an

example of the latter case is the shipment of anhydrite from Nova Scotia for American peanut farmers as a small part of the large gypsum shipments to the United States.

Consumers. Most usage is local, but some large feed and fertilizer firms no doubt purchase small volumes of gypsum.

Specifications. Land plaster is usually ground to a size of 100 mesh or smaller. Some products require 75-90 percent smaller than 100 mesh; some products allow as little as 25 percent smaller than 100 mesh. In the western United States gypsite, an impure, unsolidated gypsum is only processed to break lumps and then applied to land.

Prices. With little processing, the price of land plaster ($21.00 (Cdn) per tonne in the United States in 1987) is close to that of uncalcined gypsum (about $17.00 (Cdn)) per tonne in the United States in 1987) plus transportation costs.

Substitutes. Ground limestone (aglime) can supply calcium to the soil. Peat moss, manure, and compost can supply soil tilth. Several commercial fertilizers include sulfur in their formulation.

3.5 Consumption Estimates

Wallboard. In North America wallboard production is usually measured in terms of thousands of square feet of one-half inch board.* (Typically 0.75 tonnes (0.83 ton) of gypsum is used for each 1000 square feet of one-half inch board, thus a plant producing 250 million square feet of board would use 190 000 tonnes of gypsum.

---

*1000 square feet of ½ inch board = 93 square metres of 1.3 centimetre board

At present there is only one small wallboard plant (Corner Brook, Newfoundland) within the extended market area of the Atlantic Provinces, the Gaspé, and Maine and it has its own gypsum supply. However, there are a number of wallboard proposals outstanding including one for a mill in McAdam, N.B. and two for Cape Breton. The Corner Brook mill uses about 60 000 tonnes of gypsum per year when in operation.

Cement. Gypsum is added to cement clinker in percentages of up to 6 percent. Within the extended market area there are four cement plants:

Lafarge Canada Inc., 315 000 tonnes/year grinding capacity, Havelock, N.B. (now closed)

North Star Cement Limited 250 000 tonnes/year grinding capacity, Corner Brook, NFLD

Lafarge Canada Inc., 485 000 tonnes/year grinding capacity, Brookfield, N.S.

Dragon Products Co., unknown capacity, Thomaston, ME

Thus at peak production 50 000 - 70 000 tonnes of gypsum could be consumed for cement production in the extended market area. The likely quantity is 25 000 - 35 000 tonnes per year.

Plaster. There is a plaster plant in Windsor, N.S., the only plant in the extended market area. The quantity of gypsum consumed is unknown but likely is in the order of a few hundred tonnes per year.

Total. Within the extended market area of the Atlantic Provinces, the Gaspé, and Maine, the total consumption of gypsum is estimated at:

Wallboard	0 - 60 000	tonnes per year
Cement	25 000 - 30 000	tonnes
Other	1 000	tonnes
Total	25 000 - 91 000	tonnes per year

If another wallboard plant were opened consumption would increase by 150 000 - 200 000 tonnes per year.

4.0 BIBLIOGRAPHY (GYPSUM)

G 1 Davis, Lawrence L. "Gypsum." Preprint from 1986 Bureau of Mines and Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1987.

G 2 Stonehouse, D.H. "Gypsum and Anhydrite." Publication from Canadian Minerals Yearbook 1985, Ottawa, Ont.: Canadian Government Publishing Centre, 1986.

G 3 "Gypsum Products." Statistics Canada Catalogue 44-003.

G 4 ADI Limited. "Gypsum Wallboard Plant Feasibility Study for Border Cedar." 1986.

G 5 Zack, Gene J., ed. Pit & Quarry Directory of the U.S. Nonmetallic Mining Industries. Chicago, IL: Pit and Quarry Publications, Inc., 1982.

G 6 Pressler, Jean W. "Gypsum." Preprint, from Bulletin 675, Mineral Facts and Problems, 1985 Edition.

G 7 Metals Economics Group. "A Study of U.S. East Coast Industrial Mineral Markets for New Brunswick, Newfoundland, and Nova Scotia." New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, Open File Report 88-15, 1988.

G 8 "Market Prices." ENR, The McGraw-Hill Construction Weekly, July 1982 - April 1987.

G 9 Davis, Lawrence L. "Gypsum." Preprint from the 1985 Bureau of Mines and Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1986.

G 10 U.S. Department of the Interior, Bureau of Mines. Gypsum in 1987, Mineral Industry Surveys. Annual Preliminary.

G 11 "Non-metallic Mineral Products Industries." Annual. Statistics Canada Catalogue 44-250.

G 12 "Canada's Mineral Production, Preliminary Estimates 1987." Statistics Canada Catalogue 26-202, 1988.

G 13 Greig, E.W. "Report on Clay and Shale Deposits of New Brunswick." New Brunswick Mineral Division, Reference Report 6, 1943.

PYROPHYLLITE

P Y R O P H Y L L I T E

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	149
2.0	PRODUCTION STATUS IN NEW BRUNSWICK	150
3.0	CONSUMPTION	151
4.0	BIBLIOGRAPHY	153

LIST OF TABLES

		Page
TABLE 1	CONSUMPTION OF PYROPHYLLITE (GROUND) IN THE UNITED STATES, 1985 AND 1986	151

PYROPHYLLITE

1.0 INTRODUCTION

Definition. Pyrophyllite is a hydrous aluminum silicate with the chemical formula ($Al_2O_3.4SiO_2.H_2O$). It exists in low and medium grade metamorphic rocks that are rich in alumina. (P1)

Special properties. Properties of pyrophyllite are virtually identical to those of talc. These include:

- extreme whiteness
- softness
- smoothness
- high fusion point
- moisture content
- low electrical conductivity
- low thermal conductivity
- chemical inertness
- low oil and grease absorption. (P1)

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

Significant occurences of this material are not known in the Province and production potential is considered low.

3.0 CONSUMPTION

Uses and quantities. Industrial uses of pyrophyllite include ceramics, refractories and as a filler in paints, rubber and other products. Presented in Table 1 is a breakdown of domestically produced pyrophyllite in the United States (no figures were available for Canada).

Description. The largest use of pyrophyllite in the United States is the ceramic industry which consumed 58.1 percent in 1985 and 54.3 percent in 1986. It is assumed that ceramics is also the major consumer of pyrophyllite in Canada. Characteristics of pyrophyllite allow it to impart a very low coefficient of thermal expansion to ceramic tiles.

TABLE 1

CONSUMPTION OF PYROPHYLLITE (GROUND) IN THE UNITED STATES, 1985 AND 1986 (P2)

Use	1985 tonnes (thousands)	1985 %	1986 tonnes (thousands)	1986 %
Ceramics	65.5	58.1	58.2	54.3
Cosmetics	2.7	2.4	2.7	2.5
Insecticides	10.9	9.7	11.8	11.0
Paint	1.8	1.6	1.8	1.7
Plastics	0.9	0.8	0.9	0.8
Refractories	18.2	16.1	18.2	17.0
Roofing	1.8	1.6	1.8	1.7
Other	10.9	9.7	11.8	11.0
Total	112.7	100.0	107.2	100.0

Suppliers and Sources. Pyrophyllite is produced commercially in one province in Canada, Newfoundland. A subsidiary of American Olean Tile Company, Inc., Newfoundland Minerals Limited mines pyrophyllite from an open-pit operation near Manuels (19 km

southwest of St. John's). Other known pyrophyllite deposits occur near Stroud's Pond in the Burin Peninsula in Newfoundland, near Ashcroft and on Vancouver Island in British Columbia, and near Senneterre in Quebec. (P1)

In the United States, four firms operating six mines in California and North Carolina account for 100 percent of domestic pyrophyllite production. (P2)

Specifications. For use in ceramics, pyrophyllite must be graded minus 325 mesh and contain a minimum of quartz and sericite as impurities. (P1)

Prices. Prices for Canadian pyrophyllite vary between $33.00 - $50.00 per tonne (f.o.b. mine) for bulk materials.

Canadian imports of pyrophyllite were all from the United States. The majority of imports (94 percent) in 1985 were shipped mainly to Ontario at an average unit value of (Cdn) $78.34 per tonne. Exports to the United States, of crude pyrophyllite, were shipped to Pennsylvania and Mississippi. (P1)

Substitutes. In the ceramic industry pyrophyllite competes with talc, kaolin, fuller's earth, feldspar and other inorganic fillers. (P1)

4.0 BIBLIOGRAPHY (PYROPHYLLITE)

P 1 Prud'homme, M. "Talc, Soapstone and Pyrophyllite." Publication, from Canadian Minerals Yearbook 1986, Review and Outlook, Ottawa, Ont.: Canadian Government Publishing Centre, 1987.

P 2 Virta, Robert L. "Talc and Pyrophyllite." Preprint, from 1986 Bureau of Mines Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1987.

P 3 Clifton, Robert A. "Talc and Pyrophyllite." Preprint, from Bulletin 675, Minerals Facts and Problems, 1985 Edition.

SILICA

S I L I C A

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	159
2.0	PRODUCTION STATUS IN NEW BRUNSWICK	163
3.0	CONSUMPTION	166
	3.1 Glassmaking	166
	3.2 Flux	188
	3.3 Foundry Sand	189
	3.4 Chemicals	193
	3.5 Fracturing Sand	194
	3.6 Refractories (Bricks and Cement)	195
	3.7 Silicon Carbide	196
	3.8 Abrasives	200
	3.9 Ferrosilicon and Silicon Metal	201
	3.10 Consumption Estimates	203
4.0	BIBLIOGRAPHY	206

S I L I C A

LIST OF TABLES

		Page
TABLE 1	SUMMARY OF SILICA USE BY PRODUCT CATEGORY	160
TABLE 2	NEW BRUNSWICK SILICA (QUARTZ) PRODUCTION, 1978-1987	165
TABLE 3	ESTIMATED CANADIAN CONSUMPTION OF SILICA BY INDUSTRY, 1985	168
TABLE 4	INDUSTRIAL SAND AND GRAVEL SOLD OR USED BY PRODUCERS, BY MAJOR USE, 1986; NORTHEASTERN UNITED STATES AND UNITED STATES	169
TABLE 5	GLASS MANUFACTURERS WITHIN 800 KILOMETRES OF NEW BRUNSWICK	174
TABLE 6	CHARACTERISTICS OF PROMINENT SILICA PRODUCERS WITHIN 800 KILOMETRES OF NEW BRUNSWICK	177
TABLE 7	SPECIFICATIONS FOR SILICA SANDS - GLASS INDUSTRY	181
TABLE 8	NOMINAL SPECIFICATIONS - SILICA SAND REQUIREMENTS, DOMGLAS LTD.	182
TABLE 9	SILICA VALUES F.O.B. MINE SITE FOR QUEBEC AND ONTARIO 1979-1986	183
TABLE 10	PRODUCT SHIPMENT VALUES FOR SILICA SAND AND GRAVEL IN THE AMERICAN MARKET, 1979-1986	184
TABLE 11	PRODUCT SHIPMENT VALUES BY USE FOR INDUSTRIAL SAND AND GRAVEL USE IN GLASSMAKING IN THE NORTHEASTERN UNITED STATES	186
TABLE 12	PRICES PAID FOR SILICA BY GLASS MANUFACTURERS IN QUEBEC AND ONTARIO IN 1985	187
TABLE 13	PRIMARY USES FOR SILICA PRODUCED IN THE UNITED STATES, 1982	191
TABLE 14	PRICES PAID FOR SILICA BY FOUNDRIES IN ONTARIO, QUEBEC AND THE NORTHEASTERN UNITED STATES IN 1985	192
TABLE 15	MANUFACTURERS OF SILICON CARBIDE LOCATED WTIHIN 800 KILOMETRES OF NEW BRUNSWICK	197
TABLE 16	PRICES PAID FOR SILICA USED IN THE MANUFACTURE OF SILICON CARBIDE	199

S I L I C A

LIST OF FIGURES

		Page
FIGURE 1	ESTIMATED CANADIAN CONSUMPTION OF SILICA BY INDUSTRY, 1985	167

SILICA

1.0 INTRODUCTION

Definition. Silica (SiO_2) occurs as the mineral quartz in numerous rocks and unconsolidated sediments. Although it is a very abundant mineral, commercial sources of silica are typically restricted to high purity occurrences, including sandstones, quartzites, and unconsolidated sands. Less common sources include diatomite, vein quartz, and as a by-product of feldspar and kaolin mining. Synthetic or modified silica forms such as cristobalite, vitreous silica (flint, etc.), micro-silica, and precipitated silica can also be used as raw materials in certain applications. The commodity has a relatively low unit value and is typically mined by low-cost open pit methods.

The material is produced in three major size categories: lump silica (greater than about 5 mm), silica sand (5 mm and finer), and silica flour (very fine). The crystal form of quartz is also produced for certain applications. The uses of silica include: glass and fibreglass manufacture; metallurgical flux in smelters; manufacture of silicon carbide (SiC); as an ore of silicon (Si) and ferrosilicon (FeSi); as foundry sand for metal castings, in sandblasting; and as a mineral filler in several commodities such as paint, plastics, caulking compounds, buffing compounds, cleansers and abrasives, bricks and concrete blocks and specialty cements. Transportation is a major factor in the delivered cost of silica and proximity to consumers enhances the viability of production. Table 1 provides a summary of use by product category.

TABLE 1

SUMMARY OF SILICA USE BY PRODUCT CATEGORY

Lump silica
Flux
Si, FeSi and Si alloys
Silica brick
Lining materials in ball and tube mills
Lining and packing for acid towers
Grinding pebbles

Silica sand
Glass and glass fibre
Silicon carbide
Hydraulic fracturing
Foundry sand
Sodium silicate
Sand blasting and sand paper
Filter media in water treatment
Portland cement manufacture

Silica flour
Ceramics, enamels, frits, pottery flint
Filler, rubber, asbestos cement
Extender in paint
Abrasive in soap and scouring pads
Autoclave-cured concrete products

Quartz crystal
Electronics for its piezoelectric properties
Fusing quartz

Special properties (S1).

1. Silica is the only commercial glass-forming compound.

2. It has a very high melting temperature making it suitable for refractories, foundry sand and other high-temperature uses.

3. It is a low-cost mineral.

4. It has good compressive strength which makes it suitable for fracturing sand.

5. It is relatively abundant.

6. It has good slagging ability making it a good flux.

7. It has moderate hardness which makes it a good abrasive.

Silica also has properties which limits its use (S1).

1. Its high melting temperature creates a large and expensive energy demand in the glass making, silica carbide, and silicon metal industries.

2. Its brittleness limits the applicability of many of its products - glass, in particular.

3. Most silica uses require raw material of a very high purity which increases raw material processing requirements and costs.

4. Silica is a heavy mineral as are most of its products which limit its use for many light-weight applications. For example, one of the main reasons for the increase in plastic and aluminum containers is their lower weight relative to glass.

2.0 PRODUCTION STATUS IN NEW BRUNSWICK (S7, S10, S11)

The first commercial production of silica in New Brunswick occurred in 1974. About 10 000 tonnes were produced and used as a flux by the lead smelter at Belledune on a trial basis. A smaller quantity was produced in 1975. In 1976 Chaleur Silica Ltd. produced 15 000 tonnes and production has gradually increased to a maximum level of about 60 000 tonnes per year. In 1988 the company was purchased by Elmtree Resources Ltd.

A quarry at Bass River, about 7 km east of Bathurst, represents the raw material supply for the Chaleur operation. The Pennsylvanian Age quartzose sandstone was extracted using large boom-mounted hydraulic hammers to break the rock into manageable pieces. This method was adopted to replace blasting techniques due to the proximity of several dwellings. The material was trucked about 35 km to a facility at Petit Rocher where it was crushed and screened into various size fractions. Indoor storage was used to maintain a low moisture content and reduce the potential for frozen lumps in winter shipments of bulk material. A bagging plant, installed in 1979, was used to package 36.3 kg (80 lbs) bags. Other package sizes were also capable of being produced.

The highest rate of production achieved by Chaleur Silica Ltd. was approximately 60 000 tonnes per year. The principal market was flux for the smelter at Belledune. Other uses have included blasting sand, nursery sand, as a cement additive, and as a component in flooring manufacture.

The mineral rights to the Bass River deposits are owned by A. Ronalds and G. Ronalds under an original King's Grant and is operated by Chaleur Silica Ltd. under a royalty agreement. The deposit is a short distance from a river and the potential for

flooding combined with environmental concerns is a constraint to the long-term feasibility of the deposit. Existing known resources are gradually being depleted.

A second silica operation commenced production near Sussex in 1986. The Sussex Silica Inc. deposit is located about 22 km southwest of Sussex in the Cassidy Lake area. The source of material is a deposit of unconsolidated quartzose sand and gravel. The material is extracted from the deposit, and washed and screened on site. Much of the product is tracked to a rail loading facility in Sussex. Markets for lump silica products include use in the manufacture of silicon metal and silcon carbide at Becancour, Quebec.

Various size fractions ranging from very coarse (150 mm) to fine (100 mesh) are capable of being produced. Although some of the sizes are not currently marketed, there is product potential. Some of the fine material includes a considerable percentage of kaolin clay.

Specific markets targeted for the production are:

- Lump silica for silicon metal production;

- Silica sand for a) flint glass
  b) coloured glass
  c) silicon carbide
  d) fiberglass insulation
  e) sandblasting
  f) miscellaneous use.

Capacity of the Sussex Silica operation is estimated to be 80 000 tonnes per year. There is potential for expansion of the operation if market demand warrants.

Table 2 provides a summary of New Brunswick silica production statistics.

TABLE 2

NEW BRUNSWICK SILICA (QUARTZ) PRODUCTION (S10)
1978-1987

Year	Tonnes (Thousands)	Current Dollars (Thousands)	Constant 1987 Dollars (Thousands)
1978	NA	$ 105	$ 197
1979	28.9	324	557
1980	NA	475	741
1981	NA	1 000	1 386
1982	NA	1 400	1 752
1983	NA	1 400	1 656
1984	NA	1 250	1 417
1985P	NA	1 200	1 308
1986	NA	NA	NA
1987	NA	NA	NA

NA - data not available

3.0 CONSUMPTION

Uses and quantities. In Canada, (1985) the top four uses account for 81.7 percent of silica consumption: glass manufacture, 26.8 percent; smelter flux, 34.4 percent; foundry sand, 14.1 percent; and chemicals, 6.4 percent (see Figure 1). (S2) Although there are many minor uses for silica, most of it is consumed by a few industries. Over 65 percent of silica consumption in the United States (1985) was in glass manufacture (35 percent), foundry molds and cores (18 percent), fracturing for oil wells (7 percent) and abrasives (6 percent). (S3)

Tables 3 and 4 give detailed summaries for silica consumption in Canada and the United States, respectively.

3.1 Glassmaking*

Description. Silica is the only commercial primary glass-forming compound.** Without silica there would be no glass. Glass is formed by melting a batch of silica and other minerals, refining the mixture to ensure uniformity, working the mixture to the desired shape and annealing to relieve internal stresses. The result is a supercooled liquid having no internal molecular structure but which is transparent, rigid, hard, and brittle. (S4)

Other minerals used in glass-making include:

---

* reference. Industrial Minerals Glass Survey, 1977

** noncommercial compounds include boric oxide, phosphorus pentoxide, and arsenic oxide.

FIGURE 1

ESTIMATED CANADIAN CONSUMPTION OF SILICA
BY INDUSTRY, 1985 (S2)

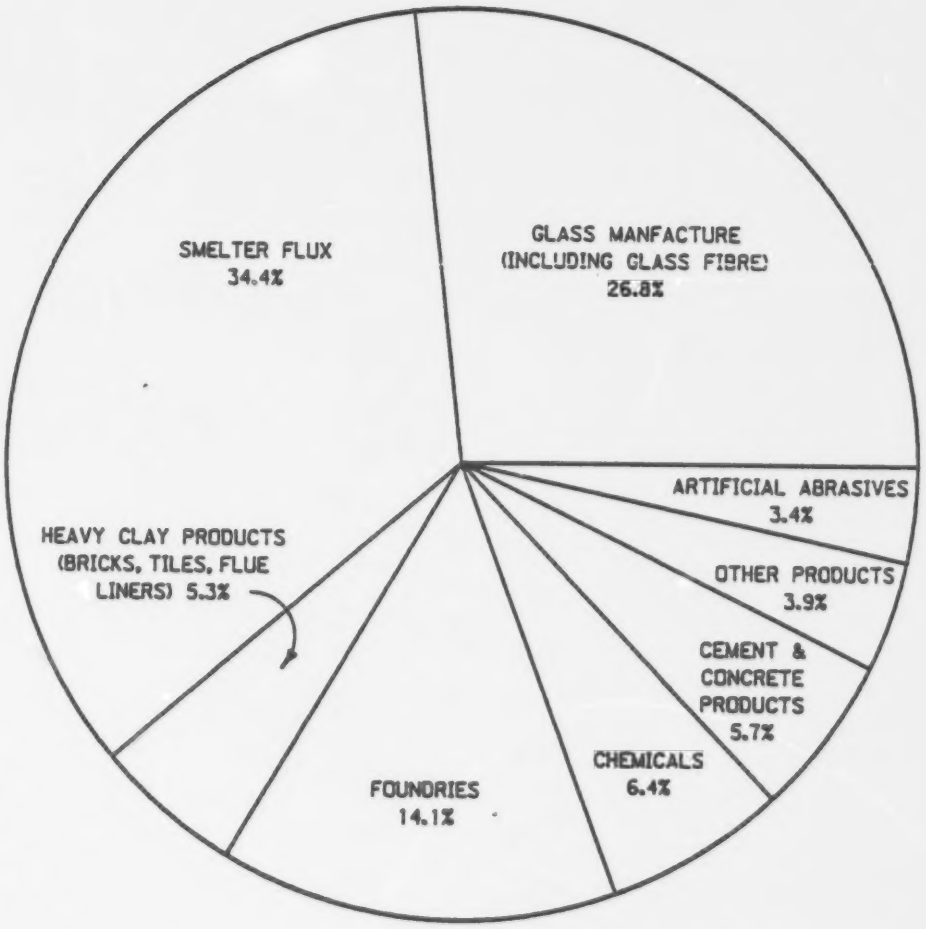


TABLE 3

ESTIMATED CANADIAN CONSUMPTION OF
SILICA BY INDUSTRY, 1985
(S2)

Industry	Tonnes (M)	%
Glass manufacture (including glass fibre)	0.835	26.8
Smelter flux	1.070	34.4
Foundries	0.439	14.1
Heavy clay products (bricks, tiles, flue liners)	0.166	5.3
Cement and concrete products	0.178	5.7
Artificial abrasives	0.105	3.4
Chemicals	0.198	6.4
Other products	0.119	3.8
Total	3.111	100.0

TABLE 4

INDUSTRIAL SAND AND GRAVEL SOLD* OR USED
BY PRODUCERS, BY MAJOR USE, 1986
- NORTHEASTERN UNITED STATES AND UNITED STATES -
(S3)

Use	Northeastern United States			United States		
	Tonnes (M)	%	Dollars (M)	Tonnes (M)	%	Dollars (M)
SAND:						
Glassmaking:						
Containers	1.201	41.1	23.009	6.892	28.3	124.984
Flat (plate and window)	W	-	W	1.769	7.3	29.932
Specialty	W	-	W	0.528	2.2	10.793
Fibreglass (unground)	W	-	W	0.467	1.9	7.823
Fibreglass (ground)	-	-	-	0.337	1.4	14.195
Foundry:						
Molding and cores	0.546	18.7	11.206	4.985	20.5	75.043
Molding and core facing (ground)	W	-	W	0.137	0.6	3.243
Refractory	W	-	W	0.130	0.5	1.896
Metallurgical:						
Silicon Carbide	W	-	W	W	-	W
Flux for metal smelting	-	-	-	0.042	0.2	0.429
Abrasives:						
Blasting	0.263	9.0	5.544	1.698	7.0	42.764
Scouring cleansers (ground)	W	-	W	0.036	0.1	1.415
Sawing and sanding	W	-	W	0.035	0.1	0.475
Chemicals (ground and unground)	W	-	W	0.288	1.2	6.091

*Canadian dollars. $Cdn = .75US

TABLE 4 (continued)

Use	Northeastern United States			United States		
	Tonnes (M)	%	Dollars (M)	Tonnes (M)	%	Dollars (M)
Fillers (ground):						
Rubber, paint, putty, etc.	0.019	0.6	1.024	0.196	0.8	15.305
Silicon flour	W	-	W	0.046	0.2	1.788
Ceramic (ground):						
Pottery, brick, tile, etc.	W	-	W	0.180	0.7	8.981
Filtration	0.304	10.4	4.916	0.449	1.8	7.436
Traction (engine)	W	-	W	0.161	0.7	2.247
Coal washing	W	-	W	W	-	W
Roofing granules and fillers	W	-	W	0.237	1.0	5.511
Hydraulic fracturing	W	-	W	1.027	4.2	27.161
Other uses, specified	0.475	16.2	11.344	NA	-	NA
Other uses, unspecified*	0.105	3.6	1.912	4.280	17.6	71.552
SUBTOTAL	2.913	99.6	58.955	23.920	98.2	459.064
GRAVEL:						
Metallurgical:						
Silicon, ferrosilicon	-	-	-	0.385	1.6	5.221
Filtration	-	-	-	W	-	W

TABLE 4 (continued)

Use	Northeastern United States			United States		
	Tonnes (M)	%	Dollars (M)	Tonnes (M)	%	Dollars (M)
Other uses	0.012	0.4	.621	W	-	W
SUBTOTAL	0.012	0.4	.621	0.440	1.8	6.471
GRAND TOTAL	2.925	100.0	59.576	24.360	100.0	465.535

W - withheld to avoid disclosing company proprietary data; included in "other uses, specified"

* - mostly estimated total production, plus other uses (small quantities) as reported by the producers

intermediates - they will not form glass independently but are involved in the process with silica.

- lead oxide, titaniam, alumina.

modifiers - they modify the glass-making process and the properties of glass.

- lime, soda ash, potash.

Glass is an important product in modern industry for the reasons listed below. (S4)

1. Transparency. Transparency is a very desirable property as it allows for the viewing of an object or process from a controlled or more comfortable environment. Examples include doors in ovens, windows in cars, bottles containing chemicals. For hundreds of years glass was the only transparent medium; now there are alternatives (plexiglass, plastic), but glass is by far the most common.

2. Corrosion resistance. By adjusting its composition glass can be made resistant to most solvents. Even with the development of plastic containers, glass bottles and beakers are still common in laboratories and hospitals.

3. Insulation. Glass has high resistance to heat and electricity transmission. The combination of glass and still air makes fibreglass an excellent insulation material. Glass insulators are no longer common but glass is used as an insulation in some electrical applications.

4. Rigidity. Windows, containers, and insulators require rigidity in most applications. The high rigidity of glass makes it preferrable to several substitutes in some applications. Examples include windows and containers where rigidity is usually more desirable than flexibility.

Companies and locations. The names and locations of major glass companies within 800 kilometres of New Brunswick are presented in Table 5. A notable feature of this table is that most glass plants are located close to population centres and large silica sand deposits (ex., New Jersey).

Sources and suppliers. The silica market for glass is not vertically integrated. Table 6 lists major silica producers within 800 kilometres of New Brunswick; however, few, if any, are owned by glass manufacturers. This lack of integration contrasts strongly with other industrial mineral industries, such as gypsum. It can be explained by the fact that many silica sand producers also produce construction sand and gravel - sometimes from the same pit. Thus silica production and silica consumption are horizontally integrated.

Specifications. Silica for glass making must meet stringent specifications (Tables 7 and 8), especially for clear glass. Small amounts of metals such as iron (Fe_2C3), alumina (Al_2O_3), cobalt, copper and chromium can act as powerful colourants and render a batch useless.

The specifications for fibreglass and other types of glass wool are much less stringent as colour control is of minor concern.

Prices. The price for glass-grade silica sand is dependent upon the specifications and quantity ordered. Coloured glass manufacturers, for example, can accept more impurities than clear glass manufacturers and thus should benefit from lower prices for equivalent quantities of material.

Tables 9 and 10 present the average values realized by producers in the sale of silica to all consumers. There is a significant variation in the values among the various provinces and states.

TABLE 5

GLASS MANUFACTURERS WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(S2)

Province/State	Location	Owner	Glass Type	Notes
New Brunswick	Scoudouc	Domglas Inc.	containers	sand supplied by Indusmin
Quebec	Montreal	Domglas Inc.	containers	sand supplied by Indusmin
	Montreal	Consumers Packaging Inc.	containers	--
	Candiac	Consumers Packaging Inc.	containers	--
Ontario	Owen Sound	PPG Canada Inc.	flat	
	Scarborough	Ford Glass Limited	flat	for automobiles
	Brampton	Domglas Inc.	containers	sand supplied by Indusmin
	Hamilton	Domglas Inc.	containers	sand supplied by Indusmin
	Toronto	Consumers Packaging Inc.	containers	
	Milton	Consumers Packaging Inc.	containers	
Massachusetts	Milford	Foster-Forbes Glass Co., Division National Can Corp.	containers	
Connecticut	Dayville	Container General Corp.	containers	

TABLE 5 (continued)

Province/State	Location	Owner	Glass Type	Notes
New York	Monroe Co.	Owens-Illinois Inc. Glass Container Div.	containers	
	Chemung Co.	Thatcher Glass Manufacturing	containers	
New Jersey	Vineland, Cumberland Co.	Owens-Illinois Inc., Kimball Div.	containers	
	Vineland, Cumberland Co.	Cumber-Wheaton Glass Co., a Div. of Wheaton Industries	containers	
	Salem, Salem Co.	Anchor Glass Container Hocking Corp.	containers	
	Bridgeton, Cumberland Co.	Kontes Glass Co.	containers	
Pennsylvania	Connellsville	Anchor Hocking Corp., Plant 5	containers	
	Montgomery Co.	Bohem Manufacturing Co.	flat	
	Brockway	Brockway Inc.	containers	
	Clarion Co.	Glass Container Corp., Parker Div.	containers	

TABLE 5 (continued)

Province/State	Location	Owner	Glass Type	Notes
Pennsylvania (continued)				
	Allegheny Co.	Glenshaw Glass Co., Inc.	containers	
	Cumberland Co.	Pennsylvania Glass Products Co.	containers	
	McKean Co.	Pierce Glass Co.	containers	
	Armstrong Co.	PPG Industries, Glass Div.	flat	
	Crawford Co.	PPG Industries, Works No. 8	flat	
	Clarion Co.	Owens-Illinois Inc. Glass Container Div.	containers	
	Luzerne Co.	Owens-Illinois Inc., Kimble Div.	containers	

Summary Statement for Table 5

Canada: Flat glass produced by 2 companies.
Glass containers produced by 8 companies.

United States: Flat glass produced by 3 companies.
Glass containers produced by 16 companies.

TABLE 6

CHARACTERISTICS OF PROMINENT SILICA PRODUCERS WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(S2, S5, S6)

Market	Company			Pits		
	Name	Size*	Location (head office)	Number	Locations	Plant
New Brunswick	Chaleur Silica Ltd.	01	Petit Rocher	1	Bass River	Yes
	Sussex Silica Inc.	01	Sussex	1	Cassidy Lake	Yes
Newfoundland	ERCO Industries Limited, (Dunville Mining Co.); a subsidiary of Tenneco Canada Inc.	N/A	Islington, Ontario	1	Villa Marie	Yes
Nova Scotia	Nova Scotia Sand & Gravel Ltd. (a subsidiary of L.E. Shaw Limited)	02	Lantz	1	Shubenacadie	Yes
Quebec	Armand Sicotte & Sons Ltd.	01	St. Hubert	1	Howick	No
	Baskatong Quartz Inc.	N/A	N/A	2	Charlevoix Lac Bouchette	Yes

See end of Table for size code

TABLE 6 (continued)

Market	Company			Pits		
	Name	Size*	Location (head office)	Number	Locations	Plant
Quebec (cont'd)	Elkem Metal Canada Inc.	N/A	N/A	1	Melocheville	
	Indusmin Ltd., (Quebec Silica Division)	03	Toronto	2	Saint-Canut Saint-Donat	Yes No
	Industrie Loma Inc.	N/A	N/A	1	Beauport	Yes
	La Compagnie Bon Sable Ltee	N/A	N/A	2	Ormstown St. Joseph-du-Lac	No
	Melocheville Mining Limited	01	Montreal	1	Melocheville	1
	Temisca Silica (1985) Inc.	N/A	N/A	N/A	Guiges Twp.	N/A
Ontario	Indusmin Ltd., (Ontario Silica Division)	04	Toronto	1	Badgeley Island	Yes
	B-Mac Silicon Aggregates Ltd.	N/A	N/A	N/A	Bracebridge	N/A

TABLE 6 (continued)

Market	Company			Pits		
	Name	Size*	Location (head office)	Number	Locations	Plant
Massachusetts	Holliston Sand Co., Inc.	01	Holliston	1	Middlesex	No
	WHIBCO, Inc.	02	Leesburg, NJ	1	Plymouth	No
Rhode Island	Holliston Sand Co., Inc.	N/A	Slatersville	1	Providence	Yes
Connecticut	The Feldspar Corp.	02	Spruce Pine, NC	1	Middlesex	Yes
	Ottawa Silica Co., Connecticut Div.	01	Ottawa, IL	1	New London	Yes
New York	WHIBCO Inc.	02	Leesburg, NJ	2	Oneida Saratoga	No No
New Jersey	Downer Silica Co.	N/A	N/A	1	Gloucester	N/A
	George F. Pettinos, Inc.	01	Williamstown Junction	1	Cumberland	Yes
	NJ Pulverizing Co.	01	Bayville	1	Ocean	Yes
	NJ Silica Sand Co.	01	Millville	1	Cumberland	Yes
	Owens-Illinois Inc.	04	Millville	1	Cumberland	No
	Pennsylvania Glass Sand Corp.	02	Berkeley Springs, WV	1 1	Cumberland	Yes

TABLE 6 (continued)

Market	Company Name	Company Size*	Company Location (head office)	Pits Number	Pits Locations	Pits Plant
New Jersey (cont'd)						
	South River Sand Co.	01	Old Bridge	1	Middlesex	Yes
	The Morie Co., Inc.	04	Millville	4	Atlantic, Camden, Cape May, Cumberland	N/A N/A N/A Yes
	Unimin Corp., Dividing Creek Plant	04	New Canaan, CT	1	Cumberland	No
	U.S. Silica Co.	N/A	N/A	1	Cumberland	N/A
	WHIBCO, Inc.	02	Leesburg, NJ	2	Cumberland	No
Pennsylvania	Alliance Sand Co.	N/A	N/A	1	Carbon	N/A
	McCrady, Inc.	01	Pittsburgh	1	Allegheny	Yes
	U.S. Silica Co.	N/A	N/A	1	Huntingdon	N/A

N/A Data not available

Size Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

TABLE 7

SPECIFICATIONS FOR SILICA SANDS - GLASS INDUSTRY
(S4)

Quality	Type	SiO_2 Min.	Al_2O_3 Max.	Fe_2O_3 Max.	CaO+MgO Max.	Grain Size/ Shape
1.	Optical	99.8	0.1	0.02	0.10	0.2-0.5 mm
2.	Flint, tableware	98.5	0.5	0.035	0.2	0.2-0.5 mm
3.	Flint	95.0	4.0	0.035	0.5	0.2-0.5 mm
4.	Sheet and rolled	98.5	0.5	0.06	0.5	0.2-0.5 mm
5.	Sheet and rolled	95.0	4.0	0.06	0.5	0.2-0.5 mm
6.	Green and window	98.0	0.5	0.3	0.5	0.2-0.5 mm
7.	Green	95.0	4.0	0.3	0.5	0.2-0.5 mm
8.	Amber	98.0	0.5	1.0	0.5	0.2-0.5 mm
9.	Amber	95.0	4.0	1.0	0.5	0.2-0.5 mm
					Max. CaO / Max. MgO	
Glass wool		30-60	3-12	<4.0	20-40 / 2-10	0.07 - 0.08 mm

TABLE 8

NOMINAL SPECIFICATIONS - SILICA SAND REQUIREMENTS
DOMGLAS LTD. (S7)

	Flint Sand	Coloured Sand
Chemical		
SiO_2	Constant ± 0.25%	Constant ± 0.4%
Fe_2O_3	0.035% Max.	0.15% Max.
Al_2O_3	Constant ± 0.05%; 2.0% Max.	Constant ± 0.15%; 2.0% Max.
CaO	Constant ± 0.15%	Constant ± 0.15%
MgO	Constant ± 0.10%	Constant ± 0.10%
Na_2O	Constant ± 0.12%	Constant ± 0.02%
K_2O	Constant ± 0.03%	Constant ± 0.04%
TiO_2	0.05% Max.	0.10% Max.
Cr_2O_3	2 PPM	0.005% Max.
CO_3O_4	Nil	Nil
MnO	Nil	
L.O.I.	0.20% Max.	0.30% Max.
Cu.	Nil	Nil
Ni.	Nil	Nil
H_2O	0.10% Max.	0.10% Max.
Organics	0.01% Max.	0.10% Max.
Physical		
Screen		
20	Nil	Nil
30	0.5% Max.	0.5% Max.
40	-	5% Max.
-100	10.0% Max.	10.0% Max.
-200	3.0% Max.	3.0% Max.

TABLE 9

SILICA VALUES (CANADIAN $/TONNE) F.O.B. MINE SITE
FOR QUEBEC AND ONTARIO, 1979-1986
(S2)

Market	1979	1980	1981	1982	1983	1984	1985	1986
Quebec	14.71	15.68	18.66	19.22	NA	19.26	20.80	19.38
Ontario	9.15	10.22	12.18	18.78	13.11	10.57	10.21	13.42
Canada	11.22	12.96	15.50	18.71	16.70	15.36	15.94	17.58

TABLE 10

PRODUCT SHIPMENT VALUES (CANADIAN $/TONNE)*
FOR SILICA SAND AND GRAVEL IN THE AMERICAN MARKET (1979-1986)--INFLATION IGNORED
(S3, S6)

State	1977 Census			1982 Census			Minerals Yearbook					
	Glass	Molding	NEC**	Glass	Molding	NEC**	1981	1982	1983	1984	1985	1986
Massachusetts	-	-	-	-	-	-	NA	16.95	NA	NA	NA	NA
Rhode Island	-	-	-	-	-	-	4.40	14.65	NA	NA	NA	NA
Connecticut	-	-	-	-	-	-	37.65	32.05	49.25	NA	NA	NA
New York	-	-	-	-	-	-	-	16.80	16.80	NA	NA	NA
New Jersey	-	11.24	7.63	17.60	13.93	-	16.80	19.30	19.55	19.30	14.70	14.70
Pennsylvania	-	-	-	-	-	-	19.35	20.55	21.00	NA	18.95	19.80
United States	8.82	9.59	14.35	17.11	13.59	28.68	16.26	17.33	18.47	17.07	16.95	NA

* FOB mine or plant after discounts and allowances, excluding freight charges (inflation ignored, 1 tonne = 1.1 short ton; 1 Can.$ = $0.75 U.S.$)

** NEC - not elsewhere classified

***These values are in current dollars and do not include shipment costs

Likely these variations are due to production quantities (New Jersey and Ontario have larger production and lower prices than Quebec or Massachusetts) and product quality. In general, prices in Canada and the United States are within the same range.

Table 11 presents values for silica shipments to glassmakers in the northeastern United States. Prices for silica paid by glass manufacturers in Quebec and Ontario are presented in Table 12. While the Canadian prices are higher, the difference is likely due to the inclusion of transportation costs--as discussed above producers prices are similar between the two countries.

Substitutes. Within the last twenty years, many glass applications have been invaded by new products. Several of these products (plastics, aluminum) have been very successful. The reasons for the success of the new products are lower costs, lower fabrication energy requirements, and lower weight. As a result, glass production has fallen dramatically. Four cases are presented below.

- glass containers. In Canada and the United States, the glass container industry is in decline. From 1980 to 1985 American shipments fell by 12.5 percent and the number of plants was reduced from 120 to 110. Coincident with the decline, manufacturers have been trying to maintain market share and profits through mergers, buyouts and closures: in the mid-1970s, there were twenty companies on the market, by 1985 there were twelve.

  Glass containers have been replaced by aluminum (beer, soft drinks), cardboard (milk, juice) and plastics (milk, food, soft drinks). The new products are lighter, easier to ship, less breakable, and often, less expensive. (S7)

TABLE 11

PRODUCT SHIPMENT VALUES (CANADIAN $/TONNE)*
BY USE FOR INDUSTRIAL SAND AND GRAVEL USE IN GLASSMAKING ON THE
NORTHEASTERN UNITED STATES* (1980-1985)
(S2)

Use	Northeast**					
	1980	1981	1982	1983	1984	1985
Sand:						
Glassmaking:						
Containers	14.17	17.09	18.89	18.19	18.83	18.79
Flat	16.13	17.64	18.99	18.38	19.10	18.21
Specialty	16.65	18.04	19.33	18.63	20.64	22.34
Fibreglass (UG)	12.07	15.31	20.49	16.13	15.68	14.66
Fibreglass (G)	13.46	15.14	18.98	51.33	58.65	85.06

Notes: G - ground, UG - underground

* Canadian $ = $0.75 US

** Northeast includes Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Pennsylvania.

***These values are in current dollars and do not include shipping costs.

TABLE 12

PRICES PAID FOR SILICA BY GLASS MANUFACTURERS
IN QUEBEC AND ONTARIO IN 1985
(CANADIAN $/TONNE)
(S7, S8)

Consumer	Location	Price	Reference
Glass	Quebec	$28.50 - $30.00 (local)	A
	Ontario (1)	$49.66 (imported)	A
	Ontario (2)	$39.60 (local)	A
	Ontario (3)	$37.00 - $40.00 (local)	B
Fibreglass	Quebec (1)	$23.00 - $30.00 (local)	A
	Quebec (2)	under $24.00	B
	Ontario	—	—

- auto glass market. With smaller cars and more imported cars, the North American auto glass market has shrunk in recent years. There is as yet no substitute for glass in car windows, but many headlight lenses are now plastic. (S7)

- glass recycling. Glass cullet is a cheaper substitute for silica in glass production. Cullet is premixed and easier to melt and, with the increased emphasis upon recycling, its use will become more common. (S7)

- building glass. There is no substitute for building glass. However, changes in architectural style can result in significant changes in the building glass market. At present, dimension stone is in vogue and glass curtain walls are in disfavour. (S7)

3.2 Flux

Description. Silica is a useful slagging agent and is widely used as a flux in the smelting of base metals. As a flux silica aids in melting and the removal of impurities in the base metal melt. The most common forms of silica used as fluxes are sandstone, silica sand and quartzite.

Silica is also used as a flux in the production of elemental phosphorus.

The major advantages of silica fluxes are their easy availability and low cost.

Companies and locations. Because of the low values associated with flux silica, only smelters or foundries within a short haul distance of New Brunswick would be market targets. The only company within short haul distance is Brunswick Mining and Smelting Corporation Limited (Smelting Division) in Belledune.

Sources and suppliers. Chaleur Silica Ltd. produces the flux silica used at Brunswick Mining and Smelting Corporation Limited (Smelting Division) in Belledune, but Sussex Silica Inc. will supply a portion of the 1988 requirement.

Specifications. To be a good flux sandstone, silica sand, or quartzite should have a high free silica content (80 percent or more) and a low iron (0.2 percent maximum as Fe_2O_3) and alumina (0.4 percent maximum as Al_2O_3). Brunswick Mining and Smelting requires 6 mm minus silica sand with a minimum of 90 percent silica and a maximum moisture content of 6 percent. (S7)

Price. No price information is available for flux silica in Canada. In the United States in 1985, flux silica cost $16.50/ tonne (f.o.b. mine site). (S2)

Substitutes. Because of its low cost and easy availability, silica flux has few substitutes.

3.3 Foundry Sand

Description. The purpose of foundry sand is to form molds for casting. For this purpose the sand must:

a) have a melting point above that of the liquid metal;

b) be able to resist the pressure as molten metal is poured into the mold;

c) be permeable to allow the escape of gases and vapours; and

d) have the texture and composition to form a smooth mold.

Silica is a popular foundry sand because it fulfills all the above requirements and is inexpensive and readily available. (S1)

Companies and locations. There are dozens of foundries within an 800 kilometre radius of New Brunswick. Unfortunately, most are at least 400 kilometres from the Province (Montreal area, Massachusetts, Connecticut, southern New York, and Pennsylvania). Relative to glass plants, foundries are small consumers of sand and a silica producer would have to combine several foundries to obtain enough demand to justify production and shipping costs. Barring that a producer would have to sell to a foundry sand supplier. Neither option would offer much opportunity to a New Brunswick producer.

As a final point, the foundry industry is in serious decline in the northeastern United States. A recent telephone survey discovered many foundries had either reduced or stopped production. The trend began during the recession of the early 1980s and has continued with the increase in imported foundry products.

Sources and suppliers. Most foundries are supplied from local sources or local suppliers (see Table 13). The small quantities of sand consumed cannot justify long haul distances.

Specifications. For foundry sand the physical properties are as important as the chemical composition. The preferred sand is highly refractory with rounded grains having frosted or pitted surfaces. The sand should grade between 20 and 200 mesh.

Chemically the sand should have a silica content in excess of 92 percent. In Britain sands of 95 percent plus are preferred with 98 percent plus becoming the norm. (S1)

Prices. Typical prices paid for foundry sand in 1985 are presented in Table 14.

TABLE 13

PRIMARY USES FOR SILICA PRODUCED IN
THE UNITED STATES (1982)
(S3)

Submarket	Production Thousand tonnes/a	Primary Uses (in order except where noted)
Massachusetts	127	foundry
Rhode Island	5	molding and foundry use
Connecticut	73	—
New York	41	molding and foundry use
New Jersey	1945	glass products (over 50%), molds and cores, refractory, sandblasting, filtration
Pennsylvania	881	glass products (over 50%), molds and cores, refractories, fillers, other

TABLE 14

PRICES PAID FOR SILICA BY FOUNDRIES IN
ONTARIO, QUEBEC, AND THE NORTHESTERN UNITED STATES IN 1985
(CANADIAN $/TONNE)
(S3, S7, S8)

Use	Location	Price	Reference
Foundry, general	Quebec (1)	$41.00 - $120.00 (imported)	S8
	Quebec (2)	$ 7.30 - $27.30 (local)	S8
	Quebec (3)	$72.00 (imported)	S7
	Ontario (1)	$12.20 (local)	S8
	Ontario (2)	$15.00 - $20.00 (local)	S7
Foundry, molding and core	northeastern USA	$12.80 (local)	S3
Foundry, molding and core facing (ground)	northeastern USA	$26.65 (local)	S3
Foundry, refractory	northeastern USA	$36.55 (local)	S3

Substitutes. Chromite, zircon, and olivine have displaced silica for certain special or severe conditions. However, because of cost and abundance, silica remains the most popular foundry sand even serving as backing for the specialty sands.

3.4 Chemicals

Description. Silica is found in several important chemicals including:

- sodium silicate: a combination of silica and sodium carbonate or sodium oxide. It is used to give hardness and durability to soaps, as a fixing agent in the textile industry (printing and finishing), and as a cleaner.

- silicon tetrachloride: produced by the chlorination of silicon, ferrosilicon or silicon carbide. Used as a modifier in plastics , a drying oil in paints and as a component of silicones.

- silicones: a combination of silicon tetrachloride and methyl magnesium chloride or silicon, methyl chloride (or chlorobenzene), trichlorosilane, and an olefine. Used as a water and stain repellent for clothes, an ingredient in polishes, cosmetics, and lubricants, an adhesion promoter, a nonstick coating for molds, and to increase electrical insulation.

- activated silica: created by agitating dilute sodium silicate in sulphuric acid, chlorine, or carbon dioxide. It is used to promote coagulation in water treatment.

- silica gel: it is used as a dessicant for removing moisture (medicines, storage space, gas drying). The gel can be recharged by drawing off the absorbed water with heat.

Companies and locations. Producers of silica-based chemicals include:

- Indusmin, Div. of Falconridge Ltd., Toronto, Silicon Dioxide

Sources and suppliers. Chemical-grade silica is supplied by any of the large (size code 03 and 04) silica producers (see Table 6).

Specifications. For sodium silicate production, the silica must be 20 to 100 mesh with a minmium silica content of 99.0 percent, and maximum contents of alumina at 1.0 percent, ferric oxide at 0.1 percent, and MgO+CaO at 0.5 percent. Sodium silicate is the most common silica based chemical. (S1)

Prices. In 1985, the unit cost of chemical-grade silica (ground and unground) in the United States was $18.50 per tonne undelivered. In Canada silica for sodium silicate was quoted at $40.00-$50.00 per tonne for Quebec (1981) and $40.00-$45.00 per tonne for Ontario; each delivered, imported material. (S2, S3)

Substitutes.

3.5 Fracturing Sand

Description. Silica sand is used in the petroleum industry to increase the flow of hydrocarbons from oil and gas wells. The sand is suspended in a fluid and injected into the wells under pressure. The pressure cracks the hydrocarbon-bearing rocks and the sand keeps the cracks open.

Companies and locations. Most fracturing sand is used in older oil and gas fields where well yields are declining due to depletion. Western Canada and the southwestern United States are

prime market areas. Within 800 kilometres of New Brunswick there are only small, scattered oil fields (Stoney Creek, western Pennsylvania) offering little potential. Proposed developments such as Hibernia would have little immediate potential.

Sources and suppliers. Most fracturing sand could be supplied quite readily from silica producers as there are few special specifications (see below).

Specifications. A sand of 20-35 mesh silica losing less than 5 percent by weight in hydrochloric acid is suitable for fracturing. (S1)

Prices. No prices were available for fracturing sand in Ontario and Quebec. In 1985, the sand was worth $25-$60 per tonne (Can. $) in the northeastern United States. (S3)

Substitutes. Low cost and easy availability are the main advantages of silica for hydraulic fracturing.

3.6 Refractories (bricks and cement)

Description. Silica bricks and cements are used as refractories in several smelting, foundry, and heating applications. Silica maintains good refractory properties to 1500C and can be used to 1700C.

Companies and locations. As discussed in the descriptions for flux sand and foundry sand, there are a number of foundries and steel mills within 800 kilometres of New Brunswick. As well, there are a few large smelters, in particular Brunswick Mining and Smelting in Belledune.

Specifications. The chemical specifications for refractory silica are similar to those for foundry sand; that is, high silica content and low concentrations of alumina, ferric oxide, and CaO. The silica is usually formed into bricks for use in furnaces.

Substitutes. Silica is considered an acid refractory (referring to operating conditions rather than silica property) and as such, competes with alumino-silicates such as clay. Basic refractories such as magnesite and dolomite and neutral refractories such as high alumina bauxite bricks have become the material of choice for many users such as steel makers leaving a diminishing market for high-quality silica bricks.

3.7 Silicon Carbide

Description. Silicon carbide is used as an abrasive, a refractory and a deoxidant in metallurgy. It is formed by heating silica and a carbon source (petroleum coke, sawdust) to a temperature of 2400C.

Silicon carbide comes in various grades depending upon purity. When used as an abrasive it must have uniform grain sizes. For refractories, it is popular as it can be formed into kiln "furniture" and other shapes. (S1, S9)

Companies and locations. Table 15 presents the manufacturers of silicon carbide located within 800 kilometres of New Brunswick. Because of the very large energy requirements in the formation of silicon carbide, all manufacturers are located in regions with low cost, plentiful energy sources and supplies. Silicon carbide requires silicon sand of a very high purity and restricted size range (see specifications). Thus, silica for this product comes from deposits of the highest purity. Much of the silica used for silicon carbide manufacture in northeastern North America is imported from the United States midwest.

TABLE 15

MANUFACTURERS OF SILICON CARBIDE
LOCATED WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(S13)

State/Province	Location	Owner	Facility	Notes
Quebec	Cap-de-la-Madeleine	Norton Co.	Silicon carbide	closed in 1983
	Shawinigan	Sohio Electro Minerals Co.	Silicon carbide	
Ontario	Thorold	The Exolon - ESK Co.	Silicon carbide and aluminum oxide	more than 800 kms from New Brunswick
	Niagara Falls	General Abrasives (a division of Dresser Industries Inc.)	Silicon carbide and fused aluminum oxide	more than 800 kms from New Brunswick
Vermont	Barre	Northern Recovery Systems Inc.	Silicon carbide	recovers silicon carbide from granite sludge
Massachusetts	Worcester	Norton Co.	general abrasives processing	no silicon carbide manufacturing

Specifications. Presented below are typical silica specifications for silicon carbide (S1, S7, S9):

Chemical:	SiO_2	99.50% minimum
	Al_2O_3	0.10% maximum
	Fe_2O_3	0.10% maximum
	CaO	0.05% maximum
	MgO	0.05% maximum
	Other impurities	0.10% maximum
	Loss on ignition	0.05% maximum

Physical:	U.S. Screen Size	% by Weight Passing
	#80	99-100
	#50	0- 20
	#100	0

Prices. Silica for silicon carbide is a relatively high value use (see Table 16).

Substitutes. As an abrasive silicon carbide competes with a wide range of natural and manufactured materials. While it seems to be maintaining its market share, the market itself is shrinking as more and more heavy industry is transferred from North America to overseas.

The same problem is present in the refractories market and, as a result, silicon carbide production is far below capacity.

An area of good potential is the use of silicon carbide in various ceramic applications. Ceramics are being heralded as the materials of the future.

TABLE 16

PRICES PAID FOR SILICA USED IN THE MANUFACTURE OF SILICON CARBIDE (S3, S7, S8)

Location	Price	Notes	Reference
Quebec	$42.80 - $43.40	Imported, delivered	S8
	$29.10 - $35.14	Local, delivered	S8
Ontario	$52.10 over $30.00	Imported, delivered	S8
Northeastern United States	$33.25	Regional, not delivered	S3

3.8 Abrasives

Description. Silica sand is a popular sandblasting medium despite its softness (hardness of 7 on Mohs scale) relative to other media. The popularity is due mainly to its low cost and widespread availability. In coated abrasives such as sandpaper, silica is used as a general abrasive and for specialty products. Minor uses of silica abrasives include soaps, cosmetics, and sawing.

Companies and location. Abrasive quality silica is supplied by silica producers to manufacturers and suppliers of abrasives or directly to large users.

Sources and suppliers. Sources are the producers of silica for glassware, flux, and foundry sand.

Specifications. For abrasives, especially sandblasting, silica needs to meet tougher physical than chemical specifications. The sand should be clean (free of clay) and of a uniform size to prevent clogging of nozzles and hoses in the sandblast equipment and to protect the surface being polished. Since the sand is usually reused, it should be tough with rounded grains.

The typical grain size distributions are (S1, S7):

	Size Range	
Grade	Mesh #	Millimetres
1	20-35	0.8 - 0.5
2	10-28	2.0 - 0.6
3	6-10	3.4 - 2.0
4	4- 8	4.8 - 2.4

Prices. Delivered prices for Quebec (1981) were quoted at $80.00 - $90.00 per tonne for imported sandblast and $23.00 - $40.00 per tonne for local material. In the northeastern United States (1985) undelivered prices were $25.75 per tonne for blasting sand, $41.05 per tonne for scouring and cleansers (ground) and $19.05 per tonne for sawing and sanding. (S3, S8)

Substitutes. There are a wide range of substitutes for silica abrasives and with the rise in concern over health effects from sandblast dust and silicosis, many are being used. Industrial diamonds, silicon carbide, emery and garnet are among the most common substitutes.

3.9 Ferrosilicon and Silicon Metal

Description. Ferrosilicon (FeSi) and silicon metal (Si) are high-value, low-quantity uses of silica. Ferrosilicon is used in the iron and steel industry where silica is an important additive. Silicon metal is used in the aluminum (again, as an additive), chemical (as a base for silica chemicals) and electronic industries.

Typical grades of ferrosilicon and silicon metal are (S14, S12):

	Silica Content	United States Silica Consumption 1986
silvery pig iron	5-24%	0.001 tonnes
ferrosilicon	25-55%	0.088 tonnes
ferrosilicon	56-70%	less than 0.001 tonnes
ferrosilicon	71-80%	0.066 tonnes
ferrosilicon	81-95%	0.001 tonnes
silicon metal	96-99%	0.110 tonnes
miscellaneous silicon alloys	48% (avg)	0.018 tonnes

Both ferrosilicon and silicon metal require very high energy inputs in their production - usually electrical power. Thus, manufacturing facilities are usually located where there is cheap, plentiful electricity.

Companies and locations. There are no American producers of ferrosilicon or silicon metal within 800 kilometres of New Brunswick. In Quebec there are plants at Beauharnois and Chicoutimi owned by Elkem Metals Canada Inc., Becancour owned by SKW Canada Inc., and Beauharnois owned by Chromasco. (S2)

Sources and suppliers. Lump silica for these products comes from Falconbridge (Indusmin) in Saint Canut, Quebec and Baskatong Quartz Inc. from Saint Urbain, Quebec and near Sussex, New Brunswick. (S2)

Specifications. Silica for silicon metal and ferrosilicon must be very pure. Since most impurities are on the surface of grains and because production requires large pieces of material, most manufacturers specify lumps in the range of 10 to 125 millimetres. Some manufacturers specify a minimum size of 25 millimetres. Chemical specifications are presented below. (S1, S7)

Silicon metal:	silica	99.5% minimum
	alumina	0.2% maximum
	ferric oxide	0.3% maximum
	phosphorus	none
	arsenic	none
Ferrosilicon:	silica	98.5% minimum
	alumina	0.4% maximum
	ferric oxide	0.5% maximum
	CaO	0.2% maximum
	MgO	0.2% maximum
	phosphate	0.1% maximum

The silica should not decrepitate below 950°C and have a minimum softening point of 1700°C.

Prices. In 1985 the undelivered price for metal-grade silica was $12.90 per tonne in the United States. (S14, S12)

Substitutes. As intermediate products, there are no substitutes for ferrosilicon and silicon metal. However, in recent years there has been a market slump for these products due to the recession of the early 1980s, the decline of heavy industry in North America and the increase in steel and steel product imports from overseas.

3.10 Consumption Estimates

Glassmaking. There is only one glassmaker - Domglas Inc. of Scoudouc, N.B. - in the extended market area of the Maritimes, Newfoundland, the Gaspé Peninsula, and Maine. The plant is supplied with silica from Quebec by Indusmin Limited/Limitee. Indusmin supplies all Domglas plants in eastern Canada. Estimated consumption is about 50 000 tonnes per year.

Flux. Flux sand is a low value use with a market area defined by transportation cost. The only smelter or foundry within market distance of New Brunswick suppliers is Brunswick Mining and Smelting Corporation Limited in Belledune. Estimated consumption is 50 000 - 60 000 tonnes per year.

Foundries. There are few large foundries within the extended market area. Consumption is likely under 2000 tonnes per year.

Chemicals, Fracturing Sand. There is very little silica consumed for these uses in the extended market area.

Silicon Carbide. Approximately 100 000 tonnes of silicon carbide (SiC) is produced annually in North America. Most of the silicon carbide is produced in Quebec and the Niagara Falls region of Ontario and New York State.

Silicon carbide is 70 percent silica by weight and requires high purity lump silica in its production. Because of the high purity requirement Sussex Silica is able to sell lump silica to a silicon carbide producer in Shawinigan, Quebec, well beyond the extended market area. Sussex Silica is not the sole supplier, however.

Estimated North America silicon carbide demand for silica is 70 000 tonnes of which a maximum 20 000 - 25 000 tonnes could be supplied from New Brunswick.

Abrasives. The demand for silica for sandblasting and other abrasive uses is falling with the increase in concern over health risks associated with silica dust. Demand in the extended market area of the Maritimes, Newfoundland, the Gaspé and Maine is likely less than 30 000 tonnes per year.

Ferrosilicon and Silicon Metal. Very high purity lump silica is required for these products. American silica demand for all grades of ferrosilicon and silicon metal is only 300 000 tonnes per year. Canadian demand is likely 100 000 tonnes, a quarter of which is accessible from New Brunswick.

Miscellaneous. There is likely 5000 tonnes of silica used within the extended market area for horticulture, landscaping and other miscellaneous uses.

Total. Within the extended market area of the Atlantic Provinces, the Gaspé and Maine, the total consumption of silica is estimated at:

glassmaking	50 000	tonnes per year
flux	50 000 - 60 000	
foundries	2 000	
chemicals, fracturing	0	
silicon carbide	20 000 - 25 000	
abrasives	30 000	
ferrosilicon and silicon metal	25 000	
miscellaneous	5 000	
	182 000 - 197 000	tonnes

4.0 BIBLIOGRAPHY (SILICA)

S 1 "Silica: World Production, Consumption and Trade." Industrial Minerals, May 1976, pp. 31-62.

S 2 Boucher, Michael A. "Silica." Publication from Canadian Minerals Yearbook, 1986, Review and Outlook, Ottawa, Ont.: Canadian Government Publishing Centre, 1987.

S 3 Tepordei, Valentin V. "Sand and Gravel." Preprint from 1986 Bureau of Mines Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1987.

S 4 Marben, P.W., ed. "Raw Materials for the Glass Industry." Industrial Minerals Glass Survey, 1977, pp. 5-105.

S 5 U.S. Department of the Interior Bureau of Mines. Directory of Industrial Sand and Gravel Producers in the United States in 1986, Mineral Industry Surveys. Annual Advance Summary Supplement.

S 6 U.S. Department of Commerce. Census of Mineral Industries. (1977, 1982).

S 7 ADI Limited. "Study of Markets for Silica and Silica Sands Accessible from Nova Scotia and New Brunswick." Supply and Services Canada, DSS File 02GS23230-5-0031, March 1986.

S 8 Allen, Réal., Bonchard, Albert., and Phu, Pham N. "La Silice Dans L'est Canadien-Etude de Marché (Silica in Eastern Canada - A Market Study)." Government of Quebec, 1983.

S 9 Dickson, Ted. "Silicon Carbide - Potential in Maturity." Source unknown.

S 10 Chandra, James J. "Mineral Production Statistics 1899-1985 New Brunswick." New Brunswick Department of Forest, Mines and Energy, Mineral Resources Division, Open File Report 86-2, 1986.

S 11 Chandra, James J., Leger J. Victor and Taggart, James L.C. "A Report on the New Brunswick Mining Industry Occupation and Economic Outlook to 1995." New Brunswick Department of Natural Resources and Energy, Mineral Resources Division, July 1986.

S 12 Neuharth, Clark R. "Silicon." Preprint, from 1986 Bureau of Mines Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1987.

S 13 Smoak, Fletcher J. "Abrasive Materials." Preprint from the 1984 Bureau of Mines Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1985.

S 14 Brown, Raymond E. "Ferroalloys." Preprint from the 1984 Bureau of Mines Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1985.

S 15 Davis L. Lawrence and Tepordei Valentin V. Preprint from Bulletin 675, Mineral Facts and Problems, 1985 Edition.

TALC

T A L C

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	211
2.0	PRODUCTION STATUS IN NEW BRUNSWICK	212
3.0	CONSUMPTION	213
4.0	BIBLIOGRAPHY	220

LIST OF TABLES

		Page
TABLE 1	CONSUMPTION OF TALC (GROUND) IN CANADA, 1984 AND 1985	214
TABLE 2	CONSUMPTION OF TALC (GROUND) IN THE UNITED STATES, 1985 AND 1986	214
TABLE 3	TALC MINING AND MANUFACTURING WITHIN 800 KILOMETRES OF NEW BRUNSWICK	216
TABLE 4	TALC PRICES	219

TALC

1.0 INTRODUCTION

Definition. Talc is a hydrous silicate of magnesium with the chemical formula ($3MgO.4SiO_2.H_2O$). The colour of talc is typically a creamy white, pale green or grey. Talc is generally used in a fine-ground state. (T1)

Special Properties. Talc is valued for its important properties. These include:

- extreme whiteness
- softness
- smoothness
- high fusion point
- moisture content
- low electrical conductivity
- low thermal conductivity
- chemical inertness
- low oil and grease absorption. (T1)

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

Significant occurences of this material are not known in the Province and production potential is considered low.

3.0 CONSUMPTION

Uses and quantities. Talc is produced in various grades which are frequently identified by the following end uses: ceramics, paints, roofing, paper, plastics, cosmetic and pharmaceutical, rubber, and insecticides. Together, these uses account for over 80 percent of consumption in Canada (see Table 1) and over 85 percent in the United States (see Table 2).

Description. In Canada, the pulp and paper industry and roofing industry accounted for 33.4 percent and 24.9 percent, respectively, in 1984, and 37.0 percent and 25.6 percent, respectively, in 1985 of the consumption of talc. In the United States, the ceramic and paint industries consumed in 1985, 32.2 percent and 15.6 percent, respectively. This increased slightly in 1986 to 34.9 percent and 17.1 percent, respectively.

Characteristics of talc permit it to act as a pitch-absorbing agent, as a paper filler and as a coating pigment in paper manufacture. The addition of talc provides a surface that is nonsticking, chemically inert, fire retardant and weather-resistant in roofing materials such as tar paper, asphalt shingles or roll roofing. Very finely ground talc increases the translucence and strength of finished products and helps to promote crack-free glazing in the ceramic industry. Another major use of quality talc is as an extender pigment and filler of paints. It influences the gloss adhesion, flow, hardness, and hiding power of paints. (T1)

Suppliers and sources. There are four main Canadian producers of talc. They are Bakertalc Inc. and Luzcan Inc. in Quebec and Canada Talc Limited and Steetley Talc Inc. in Ontario.

TABLE 1

CONSUMPTION OF TALC (GROUND) IN CANADA, 1984 AND 1985 (T1)

Use	1984 tonnes (thousands)	1984 %	1985 tonnes (thousands)	1985 %
Pulp and paper	19.7	33.4	24.0	37.0
Roofing	4.7	24.9	16.6	25.6
Paint and varnish	6.6	11.2	6.7	10.3
Gypsum	5.5	9.3	4.8	7.4
Rubber	3.3	5.6	3.7	5.7
Ceramic	3.5	5.9	2.6	4.0
Toilet preparations	1.6	2.7	1.7	2.6
Chemicals	1.0	1.7	1.1	1.7
Other Products[1]	3.1	5.3	3.6	5.6
Total	59.0	100.0	64.8	100.0

[1]Other products include fertilizers, adhesives, cleaners, bearings and brake linings, refractories and other miscellaneous uses.

TABLE 2

CONSUMPTION OF TALC (GROUND) IN THE UNITED STATES, 1985 AND 1986 (T2)

Use	1985 tonnes (thousands)	1985 %	1986 tonnes (thousands)	1986 %
Ceramics	269.1	32.2	311.8	34.9
Cosmetic	41.8	5.0	41.8	4.7
Insecticides	6.0	0.7	5.5	0.6
Paint	130.9	15.6	152.7	17.1
Paper	113.6	13.6	115.5	12.9
Plastics	63.6	7.6	62.7	7.0
Refractories	4.5	0.5	2.7	0.3
Roofing	90.9	10.9	96.4	10.8
Rubber	24.5	2.9	22.7	2.5
Other	91.8	11.0	81.8	9.2
Total	836.7	100.0	893.6	100.0

In the United States, talc was produced at 34 mines in 9 states in 1986. The principal states who produce talc include Montana, New York, Texas and Vermont.

Presented in Table 3 is a list of all the talc producers within 800 km of the New Brunswick border.

Specifications. For filler usage in pulp and paper manufacture, maximum particle size of talc should be below 20 microns. In some instances 40 micron grades can be used. Coating applications require particle size be below 10 microns and close to 1 micron for pitch control.

A low grade talc is used as a dusting agent for roofing; therefore an off colour and impure talc is often acceptable.

The average particle size of talc for many ceramics is in a range between 6 and 14 microns, with 90-98 percent of the material passing through a 325 mesh.

A fine particle size with a controlled particle size distribution, a specific oil-absorption, a low carbonate content and an almost white colour are important requirements of talc in paints. Generally, due to the variety of paints, consumers and suppliers agree on precise technical requirements. (T2)

Prices. Prices for talc vary depending on quality, degree and method of processing, specifications and transportation costs.

Canadian imports of talc were mainly from the United States (99 percent). In 1985, the unit value of talc imports was $211.50 per tonne and in 1986 it increased to $217.00 per tonne. Canadian exports of talc to the United States in 1985 was $213.69 tonne.

TABLE 3

TALC MINING AND MANUFACTURING WITHIN 800 KM OF NEW BRUNSWICK (T1, T2)

Province	Location	Owner	Facility		Notes
			Mine	Mill	
Quebec	South Bolton	Bakertalc Inc.	Underground	Mill	An expansion program was completed in 1986 which doubled capacity for high purity talc products.
	St.-Pierre-de-Broughton	Luzcan Inc.	Quarry		Formerly B.S.Q. Talc Inc. In 1985 Talcs de Luzenac of France acquired a 50% equity to form Luzcan Inc.
	Harvey Hill	International Larder Minerals Inc.	Underground	Mill	In 1986, the old Harvey Hill copper mine was to be rehabilitated to produce talc from proven reserves estimated at over 3.5 M tonnes.
Ontario	Madoc	Canada Talc Limited	Quarry		Also operate an underground mine.
	Timmins	Steetley Talc Inc.	Open-pit		Completed an expansion program in 1986, to increase capacity for new grades of talc.
	Robertsville	Ram Petroleums Limited	-		Hold mining leases on this deposit. Drilling reserves have estimated 350,000 tonnes of talc.

TABLE 3 (continued)

State	Location	Owner	Facility		Notes
			Mine	Mill	
Vermont	Chester, Windham County	OMYA Inc.	Mine	Mill	Produced and processed cosmetic and industrial grades of talc.
	Windsor, Windsor County	Windsor Minerals Inc.	Mines	Mills	One of the largest domestic producers of talc.
	Troy, Orleans County	Vermont Talc Inc.	Mines	Mill	A subsidiary of OMYA Inc.
	Chester, Windsor County	Cyprus Industrial Minerals Company	-	-	In 1986 plans were announced for the construction of an underground talc mine and a processing plant.
	Johnson, Lamoille County	Acqui-Tal Inc.	-	Mill	Acqui-Tal Inc. merged with Vermont Talc Co. in 1986.
	Johnson, Lamoille County	Eastern Magnesia Talc Co.	-	-	Closed its underground talc mine in November 1983.
New York	Gouverneur, St. Lawrence County	R.T. Vanderbilt Co. Inc.	Underground	Mill	Use was mainly for the ceramic industry and paint.

Presented in Table 4 are prices per tonne of domestic ground talc (in carload lots, free on board mine or mill, including containers); for the states of New Jersey, Vermont, New York, California and Georgia. (T1)

Substitutes. Many materials may act as a substitute for talc in its many uses; these include:

Use	Substitutes
Ceramics	pyrophyllite, feldspar, kaolin, fuller's earth
Paints	nepheline syenite, kaolin, calcium carbonate
Plastics	mica, calcium carbonate
Paper	kaolin, calcium carbonate
Roofing	clays, calcium carbonate

Talc remains to be the primary pitch control agent in the pulp and paper industry. Also, there are no economic substitutes available for cosmetics. (T3)

TABLE 4

TALC PRICES (IN CANADIAN DOLLARS)* PER TONNE (T1)

New Jersey:	
Mineral pulp, bags extra	$ 27.13 - 30.07
Vermont:	
98% through 325 mesh, bulk	102.67
99.99% through 325 mesh, bags:	
Dry processed	215.60
Water beneficiated	312.39 - 334.39
New York:	
96% through 200 mesh	90.93 - 110.00
98% to 99.25% through 325 mesh	121.73 - 146.63
100% through 325 mesh, fluid-energy ground	242.00
California:	
Standard	190.66
Fractionated	54.27 - 104.13
Micronized	220.00 - 322.66
Cosmetic steatite	64.53 - 95.33
Georgia:	
98% through 200 mesh	73.33
99% through 325 mesh	88.00
100% through 325 mesh, fluid-energy ground	146.67

*$1 Cdn = $0.75 US

4.0 BIBLIOGRAPHY (TALC)

T 1 Prud'homme, M. "Talc, Soapstone and Pyrophpyllite." Publication from Canadian Minerals Yearbook 1986, Review and Outlook, Ottawa, Ont.: Canadian Government Publishing Centre, 1987.

T 2 Virta, Robert L. "Talc and Pyrophyllite." Preprint, from 1986 Bureau of Mines Minerals Yearbook, Washington, D.C.: U.S. Government Printing Office, 1987.

T 3 Clifton, Robert A. "Talc and Pyrophyllite." Preprint, from Bulletin 675, Mineral Facts and Problems, 1985 Edition.